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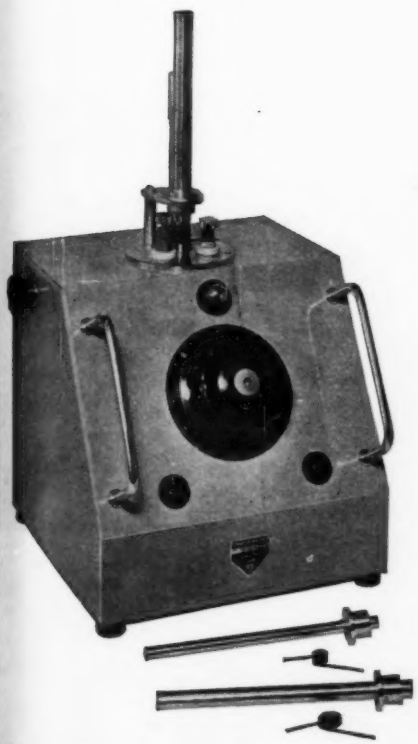

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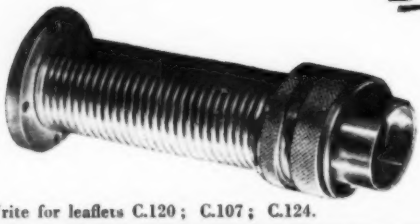

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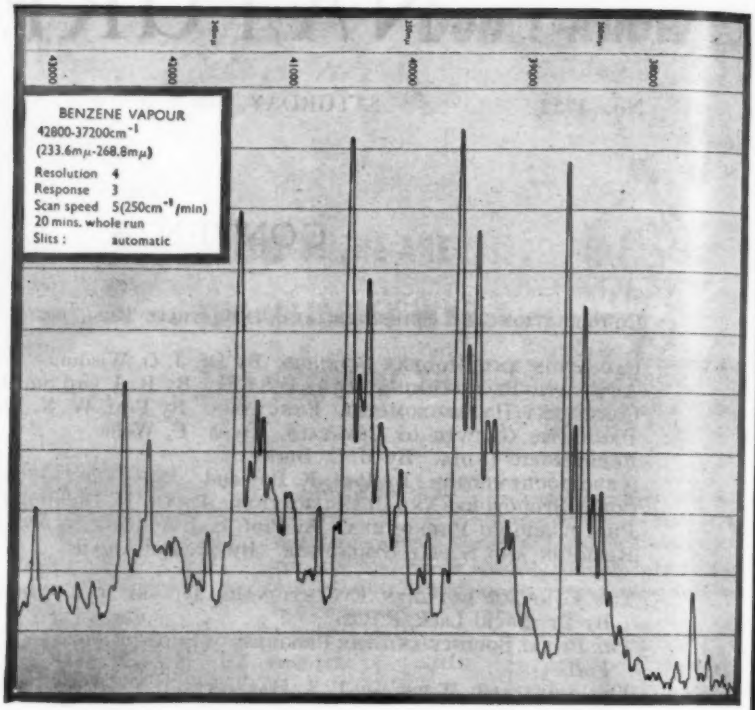

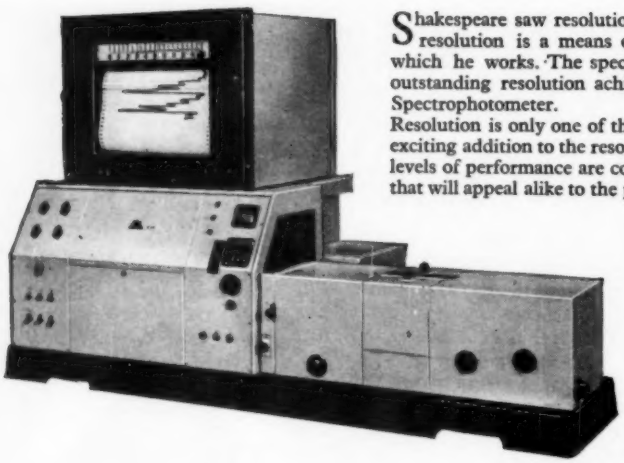

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CO-OPERATION AND SCIENTIFIC AND INDUSTRIAL RESEARCH

THE dominant impression left by a first reading of the third report from the Council for Scientific and Industrial Research, for the year 1959*, is the effort which the Council has made to provide the basis for informed judgment as the balance of the Department's effort. A new feature appears in the appendixes giving the percentage distribution of effort in the Department's research stations, 1960–61, based on the cost of staff working in particular fields in relation to the cost of total staff of the station; taken with the analyses hitherto regularly provided of the distribution by subject or field of study of research grants, studentships and fellowships, this enables the detail of the Department's contribution to the research effort of Britain to be seen more clearly. A summary of the more important financial items appears elsewhere in this issue (p. 118). With this goes a determined effort to further co-operation between the various research organizations with which the Department is concerned; this is, indeed, distinguished as one of three central themes of the report, and a feature which is likely to grow as the Council identifies, and endeavours to meet, the present and emerging needs of Great Britain for scientific and industrial research.

To this comment, one reservation must be made. The veil hitherto drawn over the activities of the Department's information or intelligence division remains unlifted. Nothing is said about the expenditure on this division, which has now been merged with the Overseas Liaison Division, and only passing reference is made to the National Lending Library for Science and Technology, apart from the appointment of a consultative committee, the representation of users on which has already drawn some adverse comment. The report refers, indeed, to the establishment last year of an *ad hoc* committee under Sir Walter Drummond to review the activities of the Headquarters Information Division and to consider how extra money might best be spent, between now and 1966, by the Division and on a scheme for assisting research associations to conduct special experiments in communication.

This Committee reported later in the year, and the Council accepted its proposals, though they are not specified. It is merely stated here that the proposals involve three main groups of services: publicity, chiefly through the mass media; publications; and stimulation of regional information services. The Council is convinced that there should be a general increase in publicity services, particularly for the Press, radio and television, and it is recruiting the necessary staff. As regards publications, its main concern is to present the Department's scientific work to wider audiences at all levels in industry, chiefly through brief summaries of useful information made available by research and through reviews of recent achievements in selected fields of inquiry. It is already supporting five regional technical information services from Conditional Aid Funds, based on Birmingham, Bristol, Cardiff, Manchester and Newcastle, and proposes to continue this support, subject to satisfactory reports on their existing and potential value for industry and to the continuation of local support. It is also proposed to consider well-founded proposals for assistance to new centres, provided there is evidence of adequate local backing. Concurrently, it is expanding the Scottish and Welsh offices of the Department.

This policy seems to be sound and reasonable, but there are two comments to be made. First, if its value is so clearly demonstrable, such a service should not be dependent on Conditional Aid Funds. Secondly, it may be questioned whether such regional technical information services could not be more efficiently and economically developed as part of the public library service as a whole. Action on the Roberts Report is still awaited, and Britain's technical and other resources are too limited to permit duplication or dissipation. It is difficult to regard the divorce of the project for a National Lending Library for Science and Technology from that for a Central Reference Library covering those fields as other than a reprehensible waste of resources and man-power. Full efficiency can only be secured as part of a genuine national system which takes full account of local resources, and the very growth of the Department's effort in the field of information makes some annual account of that effort increasingly desirable in the national interest—an account which will display that effort quantitatively as well as qualitatively between the various sections of the Information Division, the National Lending Library for Science and Technology and the grant-aided bodies, such as the Association of Special Libraries and Information Bureaux. There may be good and sufficient reasons for not publishing the report of the Drummond Committee itself; but merely as a contribution to the growing concern for co-operation between the various organizations which the Council maintains or assists it is important that full information as to their activities should be made available.

This is, in fact, a useful means of strengthening the links between research stations, the research associations, the universities and the colleges of technology—links which have this year also been reviewed by the Council. The Council comments in the present report on three new ways in which relations can be developed, apart from strengthening existing contacts and making more use of consultants and of students during the vacations. First, in awarding renewable

* Department of Scientific and Industrial Research. Report of the Research Council for the year 1959. Pp. 75. (Cmnd. 1049.) (London: H.M. Stationery Office, 1960.) 4s. 6d. net.

grants for longer-term researches to universities and colleges of technology, the Council welcomes proposals initiated by the Department's own stations as well as by the institutions to which the awards are made. Secondly, the Council suggests that stations with special apparatus or equipment could often act as hosts to users from universities and other institutions; a few, for example, might provide facilities for inspecting and trying out new laboratory apparatus and various techniques. Thirdly, it suggests the possibility of staff from the research stations offering their services, where appropriate, for teaching in universities, colleges of technology and technical colleges.

The directors of stations are being encouraged to consider all these possibilities, and the educational functions of the research associations have been stressed in earlier reports of the Department. The Council hopes that the research associations will also maintain and improve their many links with the universities and colleges, and besides setting up a Development Committee, consisting of Sir Harold Roxbee Cox (chairman), Prof. P. M. S. Blackett and Sir Willis Jackson to advise on policy in the further support of research and development in industry, the Council has established a joint committee between the Department and the National Research Development Corporation to examine development problems of common interest. The Council's Economic Committee has also initiated a series of detailed inquiries into the research and development needs of important British industries which, it believes, may be attracting too small a share of the national resources available for technological development. The results of the first inquiry, which covered the machine-tool industry, is now under discussion with representatives of the industry.

All these steps should assist in giving a clear picture of the nation's research and development needs as a whole; but it is obvious that to secure a reasonable balance, the work of the Medical Research Council and that of the Agricultural Research Council, if not of the Overseas Research Council too, must also be considered. This, of course, is the responsibility of the Minister for Science and of the Advisory Council for Scientific Policy, and apart from the direct links with other research organizations to which reference is made in this report, the Council's policy should stimulate the other research councils to develop on corresponding lines. That should certainly be true of the Council's increased help to universities and colleges in the development of their researches, which is the second feature of the report on which special emphasis is laid.

It was expected that, under the Department's second five-year plan, total expenditure on grants outside nuclear physics would be increased three- or four-fold over the period 1958–59 to 1963–64. Instead, however, of the rise being gradual, in the first academic year of the period the Council received 360 applications totalling £2·33 million, compared with 151 applications totalling only £636,000 in the previous year. The financial provision for research grants under the five-year plan has been insufficient to support all applications of sufficient merit, and this appears to be equally true of grants for nuclear physics.

With Treasury concurrence, however, the Council is entering into commitments for research grants at a substantially higher level than was contemplated in the plan, and this level will be reviewed year by year; this arrangement should enable the Council to support all applications which seem to be worth while. In 1958–59, 295 grants totalling £2,232,000 were finally made, including 52 (£826,000) in nuclear physics and 14 (£137,000) in the human sciences, compared with 119 awards totalling £445,000 in the previous year. The Department is also now the national centre for administrating the scheme for Senior Visiting Fellowships of the Organization for European Economic Co-operation, as well as the Studentships and Fellowships for Britain of the North Atlantic Treaty Organization. Postgraduate awards also expanded steadily and smoothly, although the scheme for Advanced Course Studentships did not develop so rapidly as expected.

While the Council reports that the Department now has the staff needed to handle the continued expansion of the schemes for research grants and training awards and at the same time to visit the universities and colleges of technology more often, it is obvious that the educational function of the Department will need to be kept continually under review. The Department is already playing an important part in the development of university and technological education in Britain as in our research effort, and the Minister for Science will need to have regard to its work here as well as in research. There may be implications, too, for the Minister of Education, as indeed Lord Hailsham seemed to hint at the end of his speech in the House of Lords debate on university education on May 11. Lord Hailsham raised explicitly the question whether our arrangements for co-ordination between the universities and other places of higher education are satisfactory, referring in particular to the use and location of expensive equipment such as cyclotrons, and stating that he has already asked the secretaries of the Research Councils to examine the question of the use of central facilities by universities and the use by universities of research facilities available in Government research institutes.

All these matters indeed merge into the broad question of co-operation generally which was discussed at the outset, and this question recurs in the third main theme to which the Council directs attention in the present report: the consolidation of changes which have been made in previous years in the functions and organization of some of the Department's research stations. Here the Council announces the completion of its survey of present and projected research. This year it has made no new changes in organization or scope of work. The review, however, has led the Council to reconsider the broad aims and functions of the stations as a whole, and perhaps one of the most important passages in the report is that

which sets forth the re-definition of the terms of reference of the research stations. Taken with the analysis of the distribution of effort already noted, it facilitates accurate assessment of the character of their contribution to the nation's research effort and the identification of gaps or weaknesses.

Basic research at the research stations, in the Council's view, must be directed to the general advancement of technology and applied science, although each station should be free to follow up new ideas falling within its sphere of interest and thus include some research not directed towards any immediate need of industry or the Government. Stress is laid on the need for each station to limit its work to selected carefully defined objectives, the criteria for selection being the end to which the work is directed. Directors are also to ensure that the appropriate Government interests are linked as closely as possible with the work of the station and, in consultation with research associations where appropriate, to secure financial or other co-operation with industry.

Within these terms of reference, the major purposes of the research stations may be catalogued as follows: keeping their fields of research under constant review in order to define objectives and help the Government, industry and the public to maintain a lively interest in the value of research; conducting research which can provide information to the central and to local government on matters such as air and water pollution, road safety, noise, and the extinction and prevention of fires, in which the Government has a clear responsibility for protecting the health, safety and welfare of the citizen; carrying out research and development in subjects, such as the natural resources of the country and the design and construction of buildings and roads, which are important to the Government and which affect the efficiency of industry as a whole; extending the frontiers of knowledge in applied science so that industry can be provided with the basic information required for the solution of particular problems; paying special regard to the research needs of industries that lack an adequate scientific background, and to research problems that are common to more than one industry; carrying out particular researches, in co-operation with industry wherever possible, which will enable the stations to appreciate industry's problems more fully and to recognize those fields in which more basic research is most urgently needed; providing for industry national and international standards of measurement of various fundamental physical quantities (such as length, mass and time), related secondary standards and reference materials; conducting research on matters of broad public interest; and disseminating the results of research and securing their application.

The Research Council emphasizes the last of these functions, believing it is increasingly important for the research stations to promote good relations with the users of research results. But by and large, these objectives demonstrate conclusively the reason for the existence of Government-maintained research stations. In their absence much of the work indicated is unlikely to be undertaken, or at the most in very piecemeal fashion. So far, however, as extending the frontiers of knowledge in applied science is concerned, it may be necessary to review continuously the relations of the research stations with the colleges of technology. If the latter are to develop adequately and make their full contribution to the supply of technologists, a very considerable extension of research in applied science in the colleges themselves is needed, and there may be the less need for such research by the Department's own stations. It might be noted in passing that several of the Department's stations carry out work on behalf of Colonial or overseas territories for which the Overseas Research Council might otherwise need to make special arrangements, though the Overseas Research Council is not mentioned in this report.

Three other areas of research in which opportunity for co-operation has arisen are, however, specially mentioned. First, research on creep, for which a new building is being erected at the National Engineering Laboratory, and a Creep Information Centre has been opened; the Electrical Research Association is planning an extended programme of tests designed to give new information on steels and temperatures of particular relevance to steam-raising plant and turbines for generating electric power. The National Physical Laboratory will analyse and evaluate the relevant metallurgical data, and a Committee of the British Iron and Steel Research Association is organizing co-operative creep-tests by several steel firms. Secondly, a committee has been set up under the chairmanship of Sir Alfred Pugsley to consider what research needs to be done into the fatigue of engineering structures made of metal, to survey existing research facilities and make recommendations. The third example is in shipbuilding research, and the Council emphasizes its concern that the resources of the National Physical Laboratory, including the new Ship Hydrodynamics Laboratory at Feltham, shall continue to be used to the full along with those of the British Shipbuilding Research Association and the Parsons and Marine Engineering Turbine Research and Development Association.

On the distribution of effort, it must suffice to mention the much greater emphasis the Radio Research Station is placing on research related to the Government's space programme. About half the Radio Research Station's research effort is now to be devoted to space investigation. Its study of the propagation of radio waves is to be widened, taking advantage of the new techniques provided by rockets and artificial Earth satellites. Its present studies of the world distribution of radio noise are to be supplemented over the entire radio-frequency spectrum, and later it is likely to supplement the work at Slough in predicting the tracks of satellites, and at the sub-station in Singapore, with radio telescopes and other specialized equipment. Since, however, the Department's expenditure on radio research in the year ended March 31, 1959, was a little short of £200,000 out of some £9,000,000, even with £12·7 million provided in the 1960–61 Civil Estimates,

expenditure on space research by the Council for Scientific and Industrial Research is unlikely to be excessive, unless a considerable change were made in the allocation of its resources between the different stations. Allowing for grants for promising researches in this field which the Council is making in collaboration with the Royal Society, any considerable expenditure on space research seems likely to come from Defence Estimates.

Meanwhile, the Council for Scientific and Industrial Research has clearly gone some way further to provide the basis for a sound allocation of the national resources for research and development as between the different fields. If the Minister for Science can persuade the other research councils to analyse the distribution of their own efforts on similar lines, and promote co-operation and co-ordination of effort in the way the Council for Scientific and Industrial Research is now doing, any untoward duplication and waste of effort should be eliminated with increasing ease. More important, the Minister and the Advisory Council on Scientific Policy should be in a stronger position to resist any attempt to devote an unwise proportion of effort into specific fields on the more dubious ground of prestige rather than of genuine national interest and practical return.

CAUSATION AND MODERN SCIENCE

Causality

The Place of the Causal Principle in Modern Science. By Prof. Mario Bunge. Pp. xx+380. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1959.) 60*s*. net.

THIS is an unusual book by an unusual man in a most unusual position. The author is professor of theoretical physics and philosophy of science. The university that is guilty of this stupidity or bold initiative, whichever it may be, is Buenos Aires. The author is a target for real criticism, for he is not only thoroughly competent in his two fields and presents his work with great lucidity, but also he has a strong sense of relevance and balance. Despite the fame of the subject, it is unusual to find a book of this length devoted to this one topic written without wasting words. Though the work is far from epoch making, it is of an outstanding order of competence and value, indispensable not only to those who may wish to enlighten themselves on the subject, but even to specialists on the topic. Of those who have thought carefully and written about this subject, there must be few who have been aware of the great complexity and detailed considerations that they will find here. In short, the work does not transform our view of causation, but it sets out the whole matter in such balanced and detailed perspective that anyone who attempts to discuss it without knowing this book may well be regarded as not having graduated in the subject.

The broad thesis may be put as follows. Few will require to be persuaded that not all laws and explanation in physics are causal; in fact, the pendulum has swung so far that many deny that the principle of causation has any role at all. Against this view, the author argues patiently and temperately to point out that causal laws and causal explanations do in fact exist, but he is emphatic that they are not the only kind; but he also holds that there are quite a number of non-causal types of law and explanation, and he describes these carefully. In short, his thesis is that the principle of causation takes an important role, though not a dominating one. It may be remarked that this may sound insipid, but if so, it is not insipid through compromise, but because, if the author is right, the world is governed by heterogeneous types of law. Another important part of the thesis is this. Certain thinkers, whom the author calls romantic, have denied that the causal relation connects one event with another event; and they have done so on what the author considers the correct grounds that every event is connected in innumerable ways with all sorts of other events and therefore that an event is not simply nicely and neatly connected with another one as, say, its cause. On the other hand, the romantics go on to deny that causation has any role because of the warp and weft in which events find themselves. This the author disputes, because it rests upon a misunderstanding of the nature of scientific laws, which, whether causal or not, deliberately abstract from the warp and weft and for scientific purposes isolate events satisfactorily.

The one main criticism to which this book would seem to be open is that it may fail to satisfy those who regard statistical laws as having superseded causal laws. Such critics would doubtless concede the existence of causal laws as described by the author, but insist that these should be reducible to statistical terms. It would be interesting to know whether they regard such a contention as a purely scientific one (in which case they would be refuted by the fact that science contains both types of law) or as a piece of philosophy of science (they would probably agree that it was the latter). Then the contention would seem really to concern the ultimate nature of scientific laws, and it is not easy to see what bearing this contention would have upon science itself. Further, it would be interesting to know how its exponents would set about proving the contention.

It would be valuable if critics would commit themselves on these points and if Prof. Bunge were to make a detailed reply. He would no doubt do so highly effectively.

J. O. Wisdom

AUTOMATIC PROGRAMMING IN THE U.S.S.R.

Programming Programme for the BESM Computer

By A. P. Ershov. Translated from the Russian by M. Nadler. Edited by J. P. Cleave. Pp. vi+158. (London and New York: Pergamon Press, 1959.) 60*s*. net.

AUTOMATIC programming is aimed at allowing us to present to a computer a statement of our problem in a form as close as possible to that in which we are used to expressing ourselves. This may be a mathematical form for the scientist or mathematician or perhaps 'technical English' for the business man.

The book under review describes Russian work along these lines based on a "symbolic or pseudo-mathematical" form. In my view this work is

marred by the fact that the *Besm* computer used can only accept numerical forms of information so that all the symbolism has to be recoded. It is true that the programming programme *P.P.* ('compiler' would be better understood) removes from the programmer the necessity for detailed coding of loops, operators, minimization of working space and so on, but I cannot believe that the automatic nature of the coding "practically rules out the chance of error".

The value of this book is greatly reduced by its shoddy presentation. Why must we have the translator's typewritten notes ? Smudges and smears make a number of tables and diagrams ambiguous.

Part 1 of the book describes the symbolism which the programmer must use. I feel a less fearsome notation could have been chosen. (See example on p. 21.) The numerical coding of this symbolism is inadequately described. Part 2 describes techniques for programming such things as loops, operators, and working-space economy. This is marred by the quality of some of the flow diagrams. The notation of these diagrams is not described until Part 3. This Part describes the *P.P.* itself and is the most detailed part of the book. There is undoubtedly some very useful information here.

After some rather optimistic conclusions follows a brief review of the *Besm* programming system. This part would have better been at the beginning, for implicit references are made to it earlier in the book. The ideas would have been easier to digest if more examples had been given. When these are given they are often incomplete or contain errors. The illustration of a *Besm* word on pp. 141–143 contains three errors. In spite of being, by computer standards, a rather old account and having the shortcomings described above, this is a book to be studied by those interested in the mechanism of automatic programming.

R. J. Ord Smith

CONFLUENT HYPERGEOMETRIC FUNCTIONS

Confluent Hypergeometric Functions

By Dr. L. J. Slater. Pp. ix+247. (Cambridge: At the University Press, 1960.) 65*s*. net.

THIS is the first book in English to be devoted entirely to confluent hypergeometric functions. There are two predecessors in other languages, "Die konfluente hypergeometrische Funktion" by H. Buchholz, and "Funzioni Ipergeometriche Confluenti" by F. G. Tricomi, but this book is no mere copy of its predecessors.

The general plan of the work is reminiscent of G. N. Watson's well-known "Treatise on the Theory of Bessel Functions". The first part gives the main properties of the confluent hypergeometric functions and the Whittaker functions, and the second part consists of tables—the most complete so far published—which were computed by the author on the electronic calculator *Edsac* 1 in the University Mathematical Laboratory, Cambridge.

The first three chapters are concerned with differential equations and differential and integral properties of the functions. Chapter 4 is devoted to asymptotic expansions; this is a long chapter as the theme "has been treated in great detail because it seems to cause most difficulty to students of the subject". To me this is a most impressive chapter, and I imagine that it will contain enough to meet the needs of most mathematical physicists.

Chapter 5 is given over to related differential equations and particular cases, while Chapter 6 gives the descriptive properties of the functions, such as the distribution of the zeros, expansions for the zeros, and notes on the tabulation of the zeros. There are also notes on the numerical evaluation of Kummer's function.

The second part of the work consists of tables, running to about 120 pages, giving the smallest positive zeros of Kummer's function, ${}_1F_1(a\,;\ b\,;\ x)$, and the values of this function over those ranges most useful to the computer. Since confluent functions contain one parameter more than Bessel functions, it is natural that the properties of the functions should be correspondingly less in number, and it is also natural for the tables of the functions to be much longer and more complicated in form.

This is an impressive work which contains many important contributions by the author herself, and the printing is of the high standard that one expects from the Cambridge University Press. The book should certainly be the standard book on the subject in English for many years to come, and it will be indispensable to those mathematical physicists who meet these functions in the course of their researches.

W. N. Bailey

DENDRITIC GROWTH OF CRYSTALS

Dendritic Crystallization

By D. D. Saratovkin. Translated from the Russian by Dr. J. E. S. Bradley. Second edition, revised and enlarged. Pp. iv+126. (New York: Consultants Bureau, Inc.; London: Chapman and Hall, Ltd., 1959.) 6 dollars; 50*s*. net.

THE growth of crystals is a subject of great theoretical interest and practical importance. The process is the building of a periodic three-dimensional pattern of atoms which in crystals, such as diamond or quartz, is simply a giant molecule the size of which is limited only by that of the crystal. Internally, a perfect crystal would have a regular arrangement of atoms, and its external form would be a convex polyhedron with plane faces. In fact, real crystals not only show departures from regular internal structure but also often develop shapes far removed from simple, compact, polyhedral ones. Departures from regular internal structure are known to have considerable effects on the physical and chemical properties of crystals, and the external form developed by a growing crystal is also of great importance. The repeated branching leading to fern-like growths, of which the snowflake is a well-known example, can take place not only if a crystal is growing from a solvent or vapour but also when a melt is cooled. A dendritic structure may first form and the spaces between the branches are then filled in when the remainder of the melt solidifies. Dendritic crystallization is often encountered in metallic systems.

After briefly classifying the various types of crystal growth, the author describes observations on dendrites made some ninety years ago by D. K. Chernov, described as "the famous Russian metallurgist, founder of the modern theory of metal crystallization". This section is followed by a review of existing (Russian) theories of dendritic crystallization, by

accounts of the author's microscopical studies of the crystallization of a variety of substances, and by a section dealing with the formation of dendrites in solid solutions and eutectic alloys.

This book is a very personal account reminiscent, as regards both style of writing and level of scientific attainment, of a postgraduate thesis, and the author is much pre-occupied with justifying himself in the eyes of his Russian colleagues who criticized the first edition of this book. The work is not to be regarded as typical of the quality of recent Russian scientific research. One hopes that the following excerpt (p. 20) has no sinister implication; it is also of interest as showing that the book is indeed a literal translation. "When the first edition of this book appeared I was informed that I was wasting my time to deal with views that long ago became out of date and were currently not considered. As example I was only given that the views. . . .[1] (Footnote: [1]Line missing in the original text)."

I did not find the stereoscopic micrographs very effective owing to the poor quality of the reproduction, and the method of binding (stapling and glueing of separate sheets between boards) prevents the book from opening flat. This is particularly inconvenient when stereoscopic photographs are being viewed. By English standards the book is very expensive and it would seem difficult to justify the translation of books of this quality.

A. F. Wells

PREHISTORIC INDIA

Early India and Pakistan to Ashoka

By Sir Mortimer Wheeler. (Ancient Peoples and Places, Vol. 12.) Pp. 241 (57 plates). (London: Thames and Hudson, Ltd., 1959.) 25*s*. net.

THE reader expects a first-class piece of work from the pen of Sir Mortimer Wheeler and in "Early India and Pakistan to Ashoka" he will not be disappointed. Sir Mortimer has had a very wide archæological experience not only in Britain but also in India, where he was director-general of archæology, and in Pakistan, where he was archæological adviser to the Government. Of course, the specialist on Indian archæology must not ask for a detailed account of the past history of every part of the sub-continent, but it is amazing how much has been included and what a balanced picture emerges. India and Pakistan cannot be treated as one whole, and the first couple of short chapters set the stage. Many outside influences have affected the peninsula, but owing to the great distances and the breaking up of the country into distinct areas by ranges of mountains, not everywhere were these outside influences of equal importance. Even in very early times this seems to be true. The typical Chelleo-Acheulean civilization occurs in Madras, but scarcely at all in the north, where it is replaced by something quite distinct, the early Soan.

With regard to chronology, while a relative sequence can and has been obtained, naturally only in the case of the later post-Neolithic cultures can any absolute chronology be determined. Two chapters on the Stone Ages touch on this, and the Palæolithic, Mesolithic and Neolithic cultures come briefly under review. Sir Mortimer uses the terms Upper Palæolithic and Mesolithic for want of better ones. But there are not necessarily any cultural connections with the same named cultures in western Europe. Pigmy industries in India do not necessarily denote cultures Mesolithic in time; as Sir Mortimer mentions later on, some of them occur with much more recent cultures.

The Indus civilization has been described so often that one might wonder whether there is much more to be said. This fact presents no problem to Sir Mortimer; his chapter in this volume gives shortly all the really relevant facts and paints a splendid picture of this brilliant culture which grew up by the northern river. But the Indus civilization should not blind us to developments which took place about the same time and somewhat later both in the Ganges valley and in Central India. Much has still to be learnt, especially about the former, but work has been undertaken of recent years by a number of investigators. In this connexion it is somewhat surprising that there is no mention of the many painted rock-shelters in the Central Provinces, which have been known for a long time and studied by Col. Gordon. As they seem to be associated with a pigmy tool-making culture in the process of learning to use pottery they are of some interest. Incidentally, there are some interesting rock carvings in the Indus valley which might have been worthy of a mention, though their date is, to say the least of it, doubtful.

The south Indian megaliths next come under review. Once again no connexion with our megalithic structures need be stipulated, though certain structural similarities, even the port-hole entrances, can be noted. But the date of the Indian examples is considered to be late—*c*. 300 B.C. A final chapter entitled "Ashoka" concludes the volume. This great emperor, who may have had Selucid blood in his veins, carries the story down to the period of Alexander the Great and so provides a fitting ending to the prehistory of India.

Sir Mortimer Wheeler's book gives the reader one of the best short accounts of prehistoric times in that sub-continent. Civilizations grew up early in those regions, and it is a humbling thought to recall the unsophisticated kind of life being led in western Europe at a time when the civilization of Mohenjo-daro was in full swing in the Indus valley.

M. C. Burkitt

XENOBIOCHEMISTRY

Detoxication Mechanisms

The Metabolism and Detoxication of Drugs, Toxic Substances and other Organic Compounds. By Prof. R. Tecwyn Williams. Second edition, revised and enlarged. Pp. x+796. (London: Chapman and Hall, Ltd., 1959.) 126*s*. net.

THE second edition of the book by Prof. R. Tecwyn Williams on metabolism of drugs and other organic compounds which are usually foreign to the body has been eagerly awaited, and it should be of great value to investigators in many fields. Since the first edition appeared in 1947 not only many new facts and details of metabolic changes have been discovered but also the general hypotheses of the processes have changed considerably. With the development of civilization, synthetic organic compounds are being widely used as poison gases, rubber additives, pesticides, preservatives, food flavours, contraceptives, cosmetics, as well as drugs and detergents. In order to know whether these are likely to present a toxic hazard to man and in some

cases to understand the mechanism of action, knowledge of the metabolic processes which the compounds undergo is of value.

The author explains that the short title of "Detoxication Mechanisms" has been retained, although some of the processes considered lead to the production of substances with increased rather than reduced toxicity. He suggests that the subject might be called 'xenobiochemistry' (*xenos* = strange or foreign).

Since the first edition appeared the techniques for the study of metabolism have changed enormously. The use of such aids as that of labelled compounds (particularly with carbon-14 or sulphur-35), of chromatography on columns or paper or as gas chromatography, of counter-current distribution, of electrophoresis, of spectrofluorimetry, of increased use of ultra-violet and infra-red spectroscopy and of high-speed centrifugation have increased the resources and complicated the investigations of these metabolic processes. The use of modern methods has shown these processes to be much more varied and complex than was thought twelve years ago. Most of the changes which foreign substances undergo in the mammalian body lead to increase in solubility in water and generally to the formation of ionized compounds which can be excreted in the urine or bile. The development of the ability to convert foreign compounds into derivatives which could be easily excreted was essential for animals to live on dry land. Fishes and some other aquatic animals do not possess many of the enzymes which change insoluble unionized toxic compounds into ionized harmless derivatives.

Prof. R. T. Williams is to be congratulated and thanked for his service in collecting, collating and presenting the great amount of material. Among many facts there appear to be few errors. [One on p. 193 is the statement that such a compound as 1 : 2-dihydro-1 : 2-dihydroxybenzene "is at present unknown" is probably due to the long delay in publication.] The book is well produced ; but it is a pity that the publication should take two and a half years and that the cost is so high. I hope that a third edition will be available ; but the labour which would be involved in its preparation is increasing rapidly.

E. BOYLAND

CORAL STRUCTURES AND CLASSIFICATION

Contribution à la Systématique des Madréporaires Fossiles

Par James Alloiteau. Tome 1 : Texte. Pp. 462. Tome 2 : Planches. 286 figures + 20 planches. (Paris : Centre National de la Recherche Scientifique, 1957.) 4,500 francs.

THIS is a work of importance to all concerned with the structure and classification of corals whether Recent or fossil. It has been known for several years that this thesis was awaiting publication, and some of its conclusions had already been incorporated in other works by Alloiteau and his students, notably in his section on Coelenterata in "Traité de Paléontologie", tome 1, edited by J. Piveteau (1952). But this does not detract from its importance.

The author sets out to found a classification of the hexacorals based on his investigations of the microstructure and histology of the skeletal parts of many genera and species. Some research along these lines had been carried out in the past by von Koch, Pratz, Ogilvie and others, and the classification used by Vaughan and Wells (1943) and by Wells (1956) embodied the nature of the microstructure. Alloiteau, however, gives far greater importance to it than did any of the previous workers, and arrives at classificatory conclusions which in many cases are very different from those generally accepted. Many well-known genera are split, and a large number of new ones is introduced ; sometimes this is justified, but in other cases it is doubtful. There are also new suborders and families, in addition to others Alloiteau had already introduced in 1952, but many will probably be rejected by other systematists.

The author tackles the difficult problems of the relationship of some of the hexacorals to the Palæozoic Rugosa. Thus the Amphiastraeidae of Ogilvie, which Alloiteau has raised to the position of a suborder, are considered to be derived from the Lonsdaleiidae of the Carboniferous, and the ancestors of the Turbinoliidae and Caryophylliidae are to be sought among at least four families of the rugose corals. There is a long section, too, on the evolution of the various parts of the skeleton of the Madreporaria, and the author records many useful observations and comparisons of structures in Palæozoic and later corals.

Alloiteau is led to unusual views concerning *Heliopora* (the blue coral), *Polytremacis* and the Heliolitidae. Not many will agree with his denial of any relationship between the first two, and with his erection of a new suborder of Actinanthida (= Zoantharia) to include *Polytremacis* and certain madreporarian genera. *Heliopora* itself remains, for Alloiteau, an isolated genus among the Anthozoa, with characters both of the Alcyonaria and the Actinanthida, but its histological structure is nearer to that of the latter. The Heliolitidae are also considered as Madreporaria and to have evolved from the Silurian through the Jurassic Stylinida into *Stylophora* of the Tertiary. He places a new Upper Cretaceous genus *Selidolithus* in the same family as the Silurian genus *Pycnolithus*.

One of the best services that Alloiteau renders is his re-description of the type species of several genera, based either on the original material, or, where that is lost, on neotypes. He tries to follow the International Rules of Zoological Nomenclature, but in the case of the type species of *Heliopora* he does not arrive at the same conclusion as other law-abiding systematists. Nor is his retention of the name *Cunnolites*, which he resurrected in 1952 for *Cyclolites*, in accordance with sound taxonomic principles.

The work is not easy to assimilate and would have benefited from careful revision of the typescript. The figure illustrations are beautifully drawn, as is usual in Alloiteau's papers, but many of the plate-figures are poor, and one (Plate 15, figure 9) lacks explanation. There are several mis-spellings, including that of the genus *Saltastraea* twice in headings on p. 215. The index omits references to at least seventeen important genera, including eight new ones, namely, *Dermosmiliopsis* (invalid in 1952, and now apparently only on Plate 4, figure 6), *Dichocaeniopsis* (sic—p. 264), *Haimeicyclus* (p. 105, footnote), *Heterohelia* (p. 368), *Paradichocaenia* (sic—p. 277), *Rhabdopsammia* (apparently only on Plate 4, figure 5), *Tabulocaenia* (sic—p. 187), and *Thecoseriopsis* (invalid in 1952, and now apparently only on Plate 9, figure 2).

The work is clearly a major contribution to our knowledge of the post-Palæozoic madreporarian corals, and will cause some hard thinking on the value in systematic classification of the microscopic structures of their hard parts. H. Dighton Thomas

PHOTOPERIODIC PHENOMENA

Photoperiodism and Related Phenomena in Plants and Animals

Edited by Robert B. Withrow. (Proceedings of the Conference on Photoperiodism, October 29–November 2, 1957, sponsored by the Committee on Photobiology of the National Academy of Sciences—National Research Council, and supported by the National Science Foundation.) (Publication No. 55.) Pp. xvii+903. (Washington, D.C.: American Association for the Advancement of Science; London: Bailey Bros. and Swinfen, Ltd., 1959.) 133*s*.

THIS is a record of the proceedings of a conference held in Tennessee in the autumn of 1957. It comprises the texts of all the formal contributions together with a number of short papers, presumably corresponding to some of the major items of informal discussion, which the preface optimistically calls "ideas submitted in written form". It wanders over a very wide field, sometimes straying into paths remote from photoperiodism. This breadth of cover is indicated by the eleven sections, corresponding presumably to lecture sessions, embracing photochemical principles, the photocontrol of seed germination, of vegetative growth and of reproduction in flowering plants, rhythmical phenomena in plants and animals and photoperiodic phenomena in invertebrates, in vertebrates and also in bird-migration. The object of this symposium was to promote the flow of ideas between workers on photoperiodism in the plant and animal fields. This, the main function (one might even claim it to be the only function) of the conference, was no doubt achieved at the meeting during informal contacts following the papers. But the reader of this bulky volume, in his struggle through nearly nine hundred pages of text containing a great mass of data from highly specialized research, will not easily become conscious of this flow, even if he retains the interest to look for it.

I feel strongly that the mammoth congress, catering at one and the same time for authoritative appraisals of fields of study, interim surveys of research group activities and reports of the current research of individuals, is misconceived. The publication *in full* of such a 'pot pourri' is an even greater mistake. This is not to say that a comprehensive review of current work and ideas in photoperiodic phenomena is not needed. It is in fact long overdue, and is to some extent met by this volume. There are in it a great many review papers, providing authoritative and balanced statements on the major 'growing points' of this complex of subjects. But they are cluttered up, particularly in the plant section, with specialized research contributions, which could with advantage have been omitted, particularly in view of the fact that in the intervening two years since the conference was held some have already been published in well-known journals. Some surveys also, the titles of which promise well, are disappointing, giving the impression that they are the bare bones of lectures and their writers had been pressed for time.

As with most American publications, the price is very high, and therefore calls for comment. The book should obviously find its greatest use in the hands of young research workers in this field and of advanced undergraduates, who would undoubtedly obtain valuable insight and stimulation from the better review articles. But the price is well beyond their pockets; even heads of university departments will no doubt have to balance carefully the virtues of this book against the more tangible advantages of the equally expensive encyclopædias which are now appearing and which cover this subject completely.

L. J. Audus

RELIGION AND SOCIAL STRUCTURE

Oedipus and Job in West African Religion

By Prof. Meyer Fortes. Pp. 81. (Cambridge: At the University Press, 1959.) 10*s*. 6*d*. net.

THIS book is an expanded version of the Frazer Lecture for 1956. In it Prof. Fortes gives a very interesting interpretation of the religious ideas of the Tallensi, and other West African societies, in terms of the Œdipus and Job stories, and tries to show that these ideas are reflexions of the social structure.

The aspect of the Œdipus story used here is not that made familiar by Freud: instead, it is the idea that some people are born with an evil destiny, and are never properly accepted by society; this is not of their choosing and they can do nothing about it. The interpretation of Job is that he was being tested and disciplined by a just God; Job was saved not by good works, but by recognizing his error in placing himself on a level with God.

Prof. Fortes finds parallels to these stories in West African religion, and he gives a detailed account of the ideas of the Tallensi. A parallel to Œdipus is found in their idea of good and evil predestiny: this makes sense for them of the fact that some people have persistent bad luck, fail to bear children, die of mysterious diseases, and so forth. It is believed that the ancestors are responsible, since each person is thought to be the ward of an ancestor. However, unlike the Œdipus story, it is possible to overcome an evil destiny by ritual offerings and service to the ancestors, and who Fortes sees as equivalent to Job's just God. One can be saved only by obedience and subservience to the ancestors.

A further part of the thesis of this book is that "the Tallensi have an ancestor cult because the social structure demands it" (p. 66). It is pointed out that there are different possible religious interpretations of good and bad fortune—the Azande blame it on witchcraft operated by living people, for example. The ancestor cult is a symbolic representation of the parents, resulting from the close discipline, authority and affection of the parent–child relationship.

Two general comments may be made about the book. In the first place, while the parallels drawn with European stories are interesting, and to some extent convincing, it is not made clear how the exposition or explanation of African religion is assisted by making them. Secondly, for a rigorous demonstration of the thesis that these religious ideas are a product of the social structure, a cross-cultural study would be required showing that ancestor cults are regularly associated with a certain quality of parent–child relations. Michael Argyle

Demography

By Peter R. Cox. Third edition. Pp. xiv+346. (Cambridge: At the University Press, 1959. Published for the Institute of Actuaries and the Faculty of Actuaries.) 25*s*. net.

IN the third edition of his text-book Mr. Cox has taken the opportunity of including the "Addendum" to the previous edition in his text, and of fully re-writing the text, adding in particular references to populations outside Britain. Apart from these and other minor changes in arrangement, however, the coverage remains as in the previous two editions: a text, primarily on the methods of studying population written with the needs of actuarial students principally in mind. Its main weakness as a general text on demography is imposed by the limitations of the actuarial syllabus: namely, the fact that life tables are treated in a separate publication on mortality and other investigations. A book on demography, in which life-table techniques are only treated in passing is like Hamlet without the prince, and it is to be hoped that Mr. Cox will be able to persuade his editorial committee, when he brings out further editions, to include material on life-table techniques, thus making his book much more useful for those outside the actuarial profession.

E. GREBENIK

The Instrument Manual

Third edition. Pp. viii+742. (London: United Trade Press, Ltd., 1960.) 105*s*.

EVERYONE who is directly concerned with instrument technology will need to have a copy of "The Instrument Manual" for immediate consultation and reference, but it contains so much that is of interest and value to engineers and physicists in general, particularly those active in industrial, research or teaching laboratories, that every laboratory library ought to possess at least one copy. Its price is moderate when compared with that of modern text-books and similar reference books. The format is good, the diagrams are bold and clear, and the tables and graphs are well set out for easy reading rather than economy of space. Throughout, adequate reference is made to all relevant British Standard specifications.

During the seven years since the publication of the second edition great strides have been made in British instrument development, particularly in the fields of automation and nucleonics. Nevertheless, much basic instrumentation, well proved in practice, has remained unchanged. In the present third edition, therefore, while the general scheme follows that of the second edition, the section on navigational instruments has been omitted and replaced by one on analogue computers; discussion on digital computers has been deliberately omitted; the original optical section has been dispersed, with microscopy given a section to itself and the analytical pattern of optical instruments included in the section "Analytical Instruments" which has parts devoted to polarography, gas analysis, and moisture content.

The section on nucleonic instrumentation is divided into reactor-control instrumentation, health instrumentation, laboratory instrumentation, and industrial instrumentation. In all, there are twenty-eight sections, the last two being devoted to an alphabetical list of manufacturers, their names, addresses and telephone numbers, and a list of United Kingdom organizations interested in instrumentation. In each section the basic concepts are carefully described, and the relevant theory applicable to the various types of instruments illustrated and discussed is outlined. The text is naturally limited to measurement and instrumentation, but in dealing with physical properties like viscosity and temperature, the discussion is often more up to date and more clearly expressed than in many a modern physics text-book. Appended to each section is a short bibliography and a buyers' guide.

S. WEINTROUB

Genetics, Radiobiology and Radiology Proceedings, Mid-Western Conference

Edited by Dr. Wendell G. Scott and Dr. Titus Evans. Pp. xv+149. (Oxford: Blackwell Scientific Publications; Springfield, Ill.: Charles C. Thomas, 1959.) 42*s*. net.

THIS conference was one of three convened in various parts of the United States by the National Research Council–National Academy of Sciences to provide a forum in which radiologists and geneticists could discuss the problem of the genetical hazards from radiation used for diagnostic processes.

The full proceedings of the two sessions of the conference are contained in this book.

The first session was devoted to the "Fundamentals of Radiation Genetics". It contained papers of varying standards, some of which were of an introductory nature. There were good papers by Russell and by Crow, on "Radiation Damage in Mammals" and "Population Aspects" respectively.

The second session contains papers on the problem of reducing radiation genetic effects in the medical use of X-rays. The most important papers in this section are those on gonadal radiation resulting from various diagnostic radiological proceedings, and reduction of radiation in obstetrical radiology. The standards of the other papers are lower.

The book would have been greatly improved if the papers had been edited to stress the important points and to cut out repetition. Most of the papers contain no references. However, radiologists and radiographers may find it useful to read this book, which brings genetics and radiology together within one cover.

LORNA J. LILLY

The Year Book of the Royal Society of London, 1960

Pp. 302. (No. 64.) (London: The Royal Society, 1960.) 21*s*.

THE Yearbook of the Royal Society of London, 1960, contains a list of Fellows and foreign members of the Society with their current appointments and addresses, corrected to January 1. Also included is the membership of the Royal Society committees and committees formed jointly with other bodies. The Royal Society research appointments are listed, and scientific reports of the work undertaken by Professors, Fellows and Students are included. The regulations governing these appointments are also given. To complete the volume, the statutes, the annual report of Council, medal awards and lectures, funds and a summary of the accounts are included. The Yearbook maintains its usual form and high standard of presentation. The delay in publication can, no doubt, be explained by the printing strike; but it may be regretted that it was not delayed a little longer so that it could include the 1960 election of new Fellows. However, as is the habitual practice, these have since been provided in a supplement.

THE CONFLICT BETWEEN EVOLUTIONARY THEORY AND CHRISTIAN BELIEF*

By Dr. DAVID LACK, F.R.S.

WE stand almost exactly at the centenary of the discussion on evolution between Samuel Wilberforce, Bishop of Oxford, and T. H. Huxley, held during the meeting of the British Association for the Advancement of Science at Oxford in June 1860. At the present day, most people seem to think that the problems which then aroused such excited controversy have been settled; but more searching inquiry suggests that Christians and agnostics take this view for different, and incompatible, reasons. Should we accept T. H. Huxley's statement, made a quarter of a century after the initial debate, that "the doctrine of evolution is neither Anti-Theistic nor Theistic. It simply has no more to do with Theism than the first book of Euclid has"?

In attempting to clarify the complex issues involved, I should add that, if we now see more clearly than our great-grandfathers, it is due to their efforts to reach the truth and not to our own superiority. Also, behind the conflict over evolution was a deeper division, scientists claiming that they fought for full freedom of inquiry, and theologians for the preservation of man's spiritual values.

In 1860, the most serious difficulty was the contradiction between the theory of evolution and the account of creation in Genesis, but scarcely any Christians are troubled by this to-day, since it is widely accepted that the first two chapters of Genesis are, and were intended to be, allegory, and that their spiritual message could not otherwise have been conveyed and is really unaffected by later scientific discoveries.

When animal evolution came to be accepted, the attack was turned against natural selection. On this theory, hereditary or innate changes are constantly occurring in animals, their directions being random, that is, non-adaptive, and because there is a tremendous annual mortality, on balance those hereditary traits which result in more surviving offspring are those which persist and spread in the population, while less-well-adapted innate characters are eliminated.

The critics claimed that so random a method was totally inadequate to have produced animal evolution, and after the Lamarckian view had been discredited that characters acquired during the life of the parents could be passed to their offspring, they postulated instead an external Life Force, Creative Evolution, or Holistic Urge, directing evolution along particular ways, culminating in man. Such views were first advanced chiefly by agnostics, such as Samuel Butler, Bergson and Bernard Shaw; but in recent times also by various Christians, including Canon Raven, and, in modified form, by Teilhard de Chardin.

The critics, nowadays admitting that natural selection may explain minor differences, still claim that it cannot produce big evolutionary novelties, and in particular that it cannot produce the complex, interlocking and synchronous changes, functional at every stage, that are needed for such elaborate organs as a bird's wing or the human eye. The postulated synchrony in such adaptations may not, however, be needed. For example, de Beer showed that the wing of the bird-reptile *Archaeopteryx*, though fully feathered, lacked muscles to flap it; it was evidently used for gliding. Hence part of the elaborate mechanism of bird-flight was fully evolved before another part was started, and such 'mosaic evolution' has probably been widespread. Again, in different types of animals alive to-day, one can find many intermediate conditions between a mere light-sensitive area in the skin and the elaborate focusing eye of a man or octopus, all of these stages being functional and well adapted for the animals possessing them.

It was also argued that elaborate adaptations could never have been produced 'by chance'; but this is a misconception, for selection is the reverse of chance. Moreover, the alternative to natural selection, a Life Force or Holistic Urge, solves nothing; it is merely a name for what is not understood, and introduces an unverifiable pseudo-mystical entity into the domain of science, where such concepts are inappropriate. Anyway, it implies that the hereditary changes, the mutations, are directive, whereas in fact they are random, and it is their subsequent selection that determines the directions (not direction) of evolution. It is true that natural selection has so far been proved only for small changes; but it is a reasonable inference that it has operated to produce the big evolutionary changes of the past, very gradually, and functionally at every stage.

A century ago, the one popular argument for the existence of God was Paley's, that animal adaptations are so marvellous that they must have had a Designer. Darwin showed, instead, that they came about by natural means, not as already explained by chance, but by natural causes or laws. Theologians to-day reject Paley's argument based on particular adaptations. There is, of course, a much stronger philosophical argument from design, that a universe governed by natural causes or laws must have been divinely instituted; but acceptance of the biological theory of evolution makes this argument neither weaker nor stronger than before.

Darwin's views were also feared as implying a strictly mechanistic or deterministic view of the origin of living things, including man. But all that has been demonstrated is a particular historical sequence of animals, within which only some of the many possibilities have been realized. The relationship of such a sequence to determinism, and the bearings of determinism on Christian belief, are extremely complex metaphysical questions on which, once again, particular theories of biology can throw no special light. Hence Christians were wrong to attack Darwin's theory on the grounds that it meant that evolution was 'blind', since so far as the biological evidence is concerned, they are as free to hold that the natural means of evolution are a divine creation as atheists are to deny this.

* Substance of a Friday Evening Discourse delivered at the Royal Institution on May 18.

Natural selection was also rejected because it involves a huge annual death-rate, and to humanists like Bernard Shaw it seemed inconceivable that such terrible means could have led to man, with his sense of beauty, goodness and truth. The same grounds have led various Christians to assert that the natural creation must have been distorted by a spirit of evil; but this is another instance of argument from particular designs in Nature. A truer attitude for the Christian, surely, was that of Dr. Pusey: "What are we, that we should object to any mode of creation, as unbefitting our Creator?"

At the present time, nearly all evolutionary biologists fully accept natural selection as the main means of animal evolution, but various other writers, both Christian and agnostic, have continued to advocate Creative Evolution. Prof. M. Polanyi, for example, conceiving the animal world as "a continuous ascending evolutionary achievement", wrote that "the action of the ordering principle underlying such a persistent creative trend is necessarily overlooked or denied by the theory of natural selection, since it cannot be accounted for in terms of mutation plus natural selection", and the similar views of Teilhard de Chardin, have been acclaimed as the book of the year, if not of the century. So one is led to ask why views so unacceptable to biological specialists should be so widely accepted by others. The reason may, I suggest, be different for Christians and agnostics: that Christians, still misunderstanding the metaphysical implications of natural selection, want to see evidence for theistic design in Nature, while agnostics feel that Creative Evolution may provide the justification for human values which natural selection is incapable of doing.

In answer to the Christian difficulty I may quote the Oxford theologian Dr. E. L. Mascall: "We need not worry that science describes the course of evolution in impersonal concepts; that is its job. What is reprehensible is any attempt to treat the scientific account as if it were a metaphysical one". Again "Perhaps some modern apologists have gone badly astray in looking for direct evidence of God's design in the evolutionary process. The truth may be that God is able to achieve his ends without that sort of design". He added that, "for Christian theism, no events are fortuitous in the ultimate metaphysical sense".

The agnostic objection, that natural selection cannot justify human values, requires longer treatment. Especially since the finding of fossil men and ape-men in Java, Peking and South Africa no one can seriously doubt that man's body evolved by natural means. In addition, so much innate or instinctive behaviour has now been demonstrated in man, and so much learning and social behaviour in animals, that we may reasonably conclude that at least much of man's behaviour is a product of natural evolution. But what of man's special faculties, in particular his moral conduct? Herbert Spencer postulated that good conduct was the more evolved conduct, while theories of "evolutionary ethics" have also been advocated by modern biologists such as Waddington and Sir Julian Huxley, Waddington saying in effect that the direction of evolution is good.

Two problems are involved, the origins and the value of morality. Many of man's social attitudes, including his desire to help his fellows, are so deep-seated, and find such obvious parallels in other social mammals, such as apes or dogs, that partly innate tendencies would seem to be involved, which have presumably been subject to a natural means of selection. This might be through selection of the tribe, pack or other social unit; for social behaviour must, on balance, increase the chances of survival of the group and hence of the individuals composing it. Further, there is some reason for suggesting that at least part of what we now call evil behaviour was behaviour which contributed to individual survival in the past but which came to be selected against after men started to live in groups. However, all that has been said so far refers to social behaviour, not to moral conduct, and between them there is a great difference. The worker ant is social, but not moral, while the dog is social and we hesitate about a moral faculty, but probably decide against it.

Moral conduct is involved only when a genuine choice between actions is possible. We hold that man has free-will, through introspection and through what others tell us, while on the legal plane we accept as valid the distinction between a person being responsible or irresponsible for his actions, even though it may be hard to decide in certain cases. But no test or experiment can be devised to determine whether another animal has free-will. Sometimes we may see it delay before acting, but then the biologist may say that it was subject to conflicting drives, one of which proved strongest. (This type of analysis is itself open to criticism, but the important point is that all biological interpretations leave out the possibility of the animal possessing free-will.)

Free-will depends in turn on self-awareness, which likewise we have no scientific means of demonstrating in other animals. We sometimes speak of a pet dog being pleased, or guilty, implying self-awareness, but we should strictly have said "as if pleased, or guilty", and we cannot pass beyond "as if". This is not necessarily to deny that other animals have self-awareness, but merely to say that we have no means of telling; and unless animals have free-will and self-awareness, we can scarcely speak of their having moral conduct. The gap in knowledge seems unbridgeable. This still allows the evolutionist to assert that man evolved these peculiar faculties gradually from rudiments in other animals, but it does not allow him any direct evidence for this, and it allows others to claim that, so far as free-will, self-awareness and moral conduct are concerned, there is an absolute difference between man and all other animals. (The growth from unconscious behaviour to self-awareness in the human young does not necessarily afford a parallel with the evolutionary development of the species, since the baby's self-awareness must wait on the physical maturation of the brain.)

It is even harder to find a natural basis for the value than the origin of moral conduct. The essential difficulty was put long ago by T. H. Huxley, and many hold that it has never been answered. "Cosmic evolution", he wrote, "may teach us how the good and evil tendencies of man may have come about; but, in itself, it is incompetent to furnish any better reason why what we call good is preferable to what we call evil than we had before." Thus even if good behaviour is simply that which has contributed to the survival of the group, this provides no compelling reason why we ought to be good now, nor does it sufficiently explain why, when a man knows what is right, he so often chooses what he knows to be wrong. I think it fair to say that all the attempts so far made to explain moral values on evolutionary grounds have broken down, and many claim that such attempts

will always fail because values come outside the terms of reference of science.

I suggested earlier that it was this difficulty that has particularly led various agnostic and other writers to reject natural selection. But the introduction of a Life Force does not really solve the difficulty, for we have no valid reason for postulating that such a Force, and the consequent direction of evolution, is necessarily good, while if the Life Force is good, the existence of evil is left unexplained. Indeed, while biologists have criticized Teilhard de Chardin for minimizing natural selection, theologians have done so for minimizing the problem of evil. Nor, so far as I can see, is the evolution of human self-awareness made easier by Teilhard's postulate that "we are logically forced to assume the existence in rudimentary form . . . of some sort of psyche in every corpuscle, even in those . . . whose complexity is of such a low or modest order as to render it imperceptible". Indeed, I can attach no verifiable meaning to this statement, which seems to obscure the underlying problem by misuse of the word "psyche".

The difficulty in accepting a purely natural evolution for human faculties extends also to the power of abstract reasoning. As Darwin wrote: "But then arises the doubt, can the mind of man, which has, as I fully believe, been developed from a mind as low as that possessed by the lowest animal, be trusted when it draws such grand conclusions?" This difficulty, unlike evolutionary ethics, has rarely been mentioned by biologists, and there are similar, if less urgent, problems with respect to aesthetic values.

Hence the theory of evolution, so far as it has been developed, has not yet provided a satisfactory basis for truth, beauty and goodness, and many hold that no scientific theory can ever do so. This apparently leaves the Christian free to suppose that self-awareness, free-will, and the apprehension of truth, beauty and goodness, have come as a gift from God to each human soul, while evil has resulted, in Newman's words, from "some terrible aboriginal calamity". On this view, the principle of evolutionary continuity from ape to man so properly stressed by T. H. Huxley is broken, though on a spiritual rather than a natural plane. The agnostic, rejecting such views as myth, seems equally free to hold that man evolved gradually in every respect from other animals and wholly by natural means, acknowledging that not enough is yet known to determine the origin and value of these specially human faculties; though others might argue that this view provides too weak a basis for good conduct. There are also Christians who postulate a wholly gradual evolution of man from animals, some of them supposing that animals have an interior life, if not a soul, and others acknowledging ignorance as to the means involved. There are also atheists who consider moral values inexplicable in terms of natural evolution, leaving their basis unresolved. Each of these views involves unbridged, and perhaps unbridgeable, gaps in knowledge, but it seems much better to admit these freely than to seek to bring all into a deceptive unity by the application of a theory outside its proper sphere: such as Creative Evolution, which brings a pseudo-mystical concept into natural evolution, or Evolutionary Ethics, which interpret values in terms of natural survival. Enough has been said, I hope, to justify my statement that the conflict between Darwinism and religious belief has not been settled. Yet we can scarcely afford to leave the settlement entirely to posterity, since we need a basis for our lives and actions now.

References to quotations in text
(for general history and references, see Lack, 1957)

De Beer, G. R., "*Archæopteryx lithographica*. A Study based upon the British Museum specimen" (1954).
Huxley, T. H., "On the Reception of the *Origin of Species*", chap. 5 in "The Life and Letters of Charles Darwin", ed. F. Darwin, 2, 202 (1887).
Huxley, T. H., in Huxley, T. H., and J., "Evolution and Ethics, 1893–1943", 80 (1947).
Lack, D., "Evolutionary Theory and Christian Belief" (1957).
Mascall, E. L., "The Importance of being Human", 15, 17 (1959).
Newman, J. H., "Apologia pro Vita sua", 1913 ed., 335 (1864).
Polanyi, M., "Personal Knowledge", 385 (1958).
Pusey, E. B., "Un-science, Not Science, Adverse to Faith", 52 (1878).
Teilhard de Chardin, P., "The Phenomenon of Man", 301 (1959).
Waddington, C. H., "Science and Ethics", 17 (1942).

THE ROYAL SOCIETY AND THE PROGRESS OF SCIENCE ABROAD

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THE Tercentenary Celebrations of the Royal Society during this month will be attended by a host of official guests, including some 220 representatives from forty-six countries. This galaxy of famous names in science will be a testimony to the international significance of the occasion.

There are several reasons why through the centuries the Royal Society has come not only to be recognized as the National Academy of Sciences of Great Britain but has also exercised considerable influence on the growth of science, its research problems and its contacts in Europe and far beyond.

During the sixteenth and seventeenth centuries, scientists in Italy and other countries had formed similar associations for "the promotion of natural knowledge", but most of these societies or academies had but a short life or found their work interrupted for a considerable number of years by circumstances beyond their control. The Royal Society was the first association of scientists to study the "New Philosophy" for an uninterrupted period of three hundred years. Only one year after its foundation during the reign of Charles II (who granted its Royal Charter in 1662) a similar body, the Académie des Sciences, was founded in France. However, in contrast to the relations of the English Crown to the Royal Society, the French King and his ministers exerted considerable influence on the programme of research and studies of the Académie des Sciences.

The motto of the Royal Society, "Nullius in Verba", demonstrates clearly how it tried to realize the ideals of Francis Bacon and his "House of Salomon", and

its message of truly independent scientific research was understood by many on the Continent and abroad. Similar bodies were founded with State aid during the eighteenth century in Brussels (1772), Copenhagen (1742), Berlin (1700), Göttingen (1751), Munich (1795), Turin (1783), Venice (1771), St. Petersburg (Leningrad) (1724), Madrid (1713), Prague (1700), Boston (1780) and Stockholm (1786), but none of them achieved that independence of Government control which characterizes the work of the Royal Society of London. The subtle influence of the Royal Society is none the less evident in the charters of most of these bodies.

However, the Royal Society's activities have had much more tangible influences on foreign research. Like most seventeenth-century learned bodies, the Royal Society started a collection of foreign animals, plants, minerals and instruments, the nucleus of which was formed by the "collection of rarities", bought from Mr. Hubbard for the sum of £100 in 1666. Sprat, in his "History of the Royal Society", mentions how at a very early date it started to "collect and send abroad inquiries" about the East Indies, China, St. Helena, Teneriffe, "Ginny, Barbary and Morocco", Spain, and Portugal, Turkey, France, Italy, Germany, Hungary, Transylvania, Poland, Sweden, Iceland and Greenland. As an example of such contacts abroad, from whom data on the local flora, fauna and geology were collected, he prints the full text of an "Inquiry" sent by Sir Robert Murray to Sir Philiberto Vernatti, "resident in Batavia in Java Minor".

More lasting contacts were undoubtedly established by the Royal Society's decision to make possible the printing of its Fellows' papers and other memoirs of scientific investigations. On March 6, 1665, Henry Oldenburg, secretary of the Royal Society and one of the most prolific correspondents of the century, published the first number of the "Philosophical Transactions: giving some Account of the present Undertakings, Studies and Labours of the Ingenious in many considerable Parts of the World". The very sub-title of this first scientific periodical shows that it would not be confined to the publication of memoirs submitted by Fellows of the Royal Society. Its columns were thrown open to any scientist, wherever he lived, provided his work came up to certain standards.

This step was a most significant one for science in general. Up to that date, the students of the 'New Philosophy' had been able to communicate their results and their theories to a local circle of friends only. Some managed to have them printed in pamphlet or book form, but it was virtually impossible to submit them for discussion to an international forum of critical fellow-scientists. Hence such data and theories took a very long time to spread. Oldenburg's effort solved the most important problem of communication of the day. A memoir published in the *Philosophical Transactions* could now produce reactions within a matter of months, where earlier workers had had to wait a generation before their results were absorbed and seriously discussed by foreign fellow-scientists.

A striking example of this feature of the *Philosophical Transactions* can be found in the correspondence of Anthoni van Leeuwenhoek published in the volumes from 1673 onwards. Van Leeuwenhoek was a native of Delft and one of the pioneers in the world hidden from the naked eye but penetrated by the use of lenses. With his 'microscopes' (in reality single lenses mounted between two small silver plates) he magnified the objects studied 200–250 times. As he did not speak or write English, the letters recording his adventures in this microcosmos were translated with the help of his fellow-townsman, the physician Reinier de Graaf, who was already corresponding with the Royal Society, and other friends. For nearly fifty years, most of the 280 letters written by him as well as a number of the 550 microscopes which he made, with objects mounted for observation, went to the Royal Society. The secretary published some 124 letters by van Leeuwenhoek during the fifty years of contact which the Royal Society had with him, as well as the observations by Robert Hooke, who often tried to repeat and equal the results of van Leeuwenhoek. However, Hooke possessed only a compound microscope, consisting of a very small plano-convex object glass and a large plano-convex eye-piece, which magnified his objects only about 40 times. This difference in their 'penetration' of the microcosmos led to violent accusations of misrepresentations on both sides; but from the discussions and the part taken by other scientists very valuable results ensued for microbiology and other fields of science.

The publication of his letters in the *Philosophical Transactions* soon made van Leeuwenhoek famous, and a correspondence with other scientists or amateurs ensued. Among his correspondents we find not only all the famous men in the United Provinces but also the Elector Palatine, the Landgrave of Hesse-Cassel, the chief librarian of Cosimo III, Duke of Tuscany, Leibniz and von Tschirnhaus. Even princes came to see him at his Delft home.

This is but a typical example of the benefits which many a Continental scientist derived from having his papers printed through the good offices of the Royal Society. In certain cases the Royal Society also had longer memoirs and books printed. In the early period, when funds were not always adequate, the Royal Society could not always publish these works itself and merely sanctioned their publication. In this way Newton's famous "Principia" received the Society's 'imprimatur' from the then president, Samuel Pepys, to be printed at the expense of Edmond Halley, the astronomer. However, this sponsoring of larger publications was not restricted to the work of English subjects only. As early as 1669 the Society published a book on the silkworm by the famous Italian biologist Marcello Malpighi, who was in constant correspondence with Robert Hooke. Six years later, in 1675, another book by Malpighi, on plant anatomy, was published by the Royal Society, which also helped to print his work posthumously in 1697. Among these early publications we also find two volumes on the "New Digester or Softener of Bones" (1681 and 1687), invented by the French physician, Denis Papin, who during certain periods of his life was the assistant of Huygens and of Boyle. These two publications deal with the ancestor of the modern 'pressure-cooker'.

Even during the early eighteenth century when the Society's scientific activities were at their lowest ebb, both the *Philosophical Transactions* and the series of publications maintained the high standard which still characterizes them to this very day.

The third way of promoting science abroad was the election of foreign scientists as Fellows. Not only was Anthoni van Leeuwenhoek thus rewarded in 1689, but in the earliest registers of Fellows we find the names of the Dutch physician, Christiaan Huygens (1663), the Frenchman Samuel Sorbière (1663),

Marcello Malpighi (1669), the French astronomer Jean Casini (1672), the German mathematician and philosopher G. W. Freiherr von Leibniz (1673) and Denis Papin (1682), to name but a few of the scientists whose fame has survived the centuries. In 1671 the Royal Society had twelve foreign members; this number had risen to twenty-four by the end of the century. During the eighteenth century, too many distinguished foreigners were admitted who had no scientific qualifications, and by 1766 there were no less than 170 foreign members. This gave rise to provisions for the much closer scrutiny of the qualifications of such candidates (1761 and 1765). In the Statutes of 1786 their number was limited to 100, and in 1823 this maximum number was fixed at 50. At the present time 68 foreign members enjoy the privilege of belonging to the Royal Society, all of whom are scientists famous in their special field, many being Nobel Prize winners.

As the international brotherhood of scientists became more firmly established, the Fellows of the Royal Society also established more personal contacts abroad. In his recent charming book, "The Sciences were never at War", Sir Gavin de Beer has shown how prominent Fellows like Sir Joseph Banks, president of the Royal Society from 1778 until 1820, took considerable risks during the Revolutionary and Napoleonic Wars with France to extend a helping hand to French fellow-scientists in trouble because of war conditions. This involved him in serious difficulties with the British Government; but notwithstanding these risks, letters and books still went to and fro between Great Britain and France in war-time, and no French scientist in difficulties in British-occupied territories called upon the Royal Society in vain.

In Banks's days, joint ventures with foreign scientific bodies were already common features in the Royal Society's programme, quite apart from its own naturalist and astronomical expeditions. Thus in 1785, King George III authorized a grant needed for a triangulation from Greenwich, which connected across the Channel with similar French triangulations from the Observatoire Royal. This was but one of the many co-operative ventures which culminated recently in the antarctic expedition in connexion with the International Geophysical Year, when the Royal Society established a station at Halley Bay for various scientific observations. Just after the First World War, the Royal Society took the initiative in re-establishing international co-operation, which resulted in the setting-up of the International Research Council, reconstituted in 1931 as the International Council of Scientific Unions. Through this International Council and through the United Nations Educational, Scientific and Cultural Organization, the Royal Society is now very active in promoting international research and not least in disseminating scientific knowledge, as it has done for centuries. The latter effort culminated in the Scientific Information Conference of 1948, held to establish the proper means of disseminating scientific information in general. Through its numerous committees the Society now co-operates with a variety of international commissions and in various international scientific projects, true to its motto, that research knows no master but is for the benefit of mankind as a whole.

THE SCIENTIFIC WORK OF J. S. HALDANE (1860-1936)

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MY father, J. S. Haldane, was born in 1860. He took arts and medical degrees at the University of Edinburgh, and spent a year in German universities. Although he worked in the Physiological Laboratory at Oxford during 1890–1916, for most of which time he was lecturer or reader, his main source of income in the present century was from his employment as a gas referee; and among the posts which he held in his last decade were the chair of mining at Birmingham, the presidency of the Institution of Mining Engineers, and the Gifford lectureship on philosophy. In this brief sketch I deal mainly with his contributions to physiology, and only touch on his other activities so far as they were relevant to this. The bibliography only includes a few of his publications—those which in my opinion can be read with most profit to-day.

His first two publications set the pattern for the future. The first was on "Life and Mechanism" in *Mind*. The second[1] with Carnelley and Anderson on the air of Dundee houses and schools, and a third with Carnelley on the air of sewers, are records of numerous analyses. They attacked the hypotheses, then widely held, that such diseases as typhoid fever were due to 'bad air', and that the effects of overcrowding were due to chemical changes in air, rather than to bacteria.

His next important publication[2], with J. L. Smith, refers to work done at Oxford. A subject was shut up in an airtight chamber, with or without a tray of soda-lime to absorb carbon dioxide; or mixtures were breathed from bags. The highest and lowest concentrations breathed were 18·6 per cent carbon dioxide and 6·7 per cent oxygen. Their conclusions as to the physiological effects of these gases, which disagreed completely with those of several contemporaries, are now universally accepted. They also found that water condensed from breath was no more poisonous, when injected into rabbits, than any other distilled water, whereas the contrary had been claimed.

In 1894, he began going down mines to collect air samples, and established the composition of 'blackdamp' in which oxygen is deficient, and carbon dioxide in excess. But his main interest was in carbon monoxide, on the effects of which he published a paper[3] in 1895. He found that 0·06 per cent carbon monoxide produced symptoms in mice when added to the air breathed, while 0·2 per cent was fatal. When added to pure oxygen about ten times as much carbon monoxide is needed. He then himself breathed mixtures containing carbon monoxide. He reached 49 per cent saturation of his hæmoglobin, at which point "stopped experiment. Vision dim.

Limbs weak. Had some difficulty in getting up or walking without assistance, movements being very uncertain". When a mouse breathed the same mixture as a man the final results were not very different, but symptoms appeared in about one-twentieth of the time. He at once applied this fact to the detection of carbon monoxide in mines while collecting gas samples from heated coal. He later found that small birds, with their higher gas exchange per gram per minute, reacted still quicker. In the next year he went down three collieries which had recently exploded, took samples of blood from dead men and horses, and concluded that they had died of carbon monoxide poisoning. In the course of this work he developed analytical methods which were later improved.

In 1896, Haldane and Lorrain Smith found that when a man is in equilibrium with a small percentage of carbon monoxide, his blood contains less of this substance than when it is equilibrated with a gas mixture believed to approximate to his alveolar air. Later work with Douglas confirmed this conclusion. His explanation that this is due to oxygen secretion by the lungs has been strongly criticized, but the facts must be explained. They also found that light decomposes carboxyhæmoglobin. He made a number of experiments on hæmoglobin derivatives, giving spectra of several new ones, and making the important discovery[4] that when ferricyanide is added to oxy-hæmoglobin the oxygen is given off quantitatively. This was the basis of his subsequent work on oxygen transport. He also[5] described the gas-analysis apparatus which bears his name.

During the last two years of the nineteenth century he was largely occupied with other matters. He took the teaching of physiological chemistry seriously, and was, for example, the first to use Kjehldahl's method of nitrogen estimation in Britain. Among his publications in applied physiology at this time are reports on three colliery explosions, in which he recommended the use of rescue apparatus, after personal experience with one of his own design, on poisoning by lighting gas, and on the air of the London Metropolitan railway, the electrification of which he recommended.

The period 1900–14 was the most productive of his life. In 1900, with Smith[6], he administered about 120 ml. of carbon monoxide in closed-circuit breathing apparatus to 12 men. About 20 per cent of their hæmoglobin combined with this gas, and he thus determined their blood volumes. In the next year[7] he established standards of hæmoglobin for men, women and children, using his well-known pocket hæmoglobinometer; and in 1902, with Barcroft, described a blood gas manometer the subsequent modifications of which by Barcroft, Brodie and Warburg have been very widely used for many purposes.

In 1901 he found that an outbreak of anæmia in Cornish tin mines ascribed to 'bad air' was due to ankylostomiasis, and later, with A. E. Boycott[8], described its course and eradication. During this investigation he became interested in the much more serious disease, miners' phthisis, and with R. A. Thomas[9] proved that it was due to rock dust. It had been attributed to nitrogen peroxide, ladder climbing, and even lack of sunlight. The fact that it is now called pneumoconiosis is sufficient proof that his views have been accepted. He continued work on it for the rest of his life.

In 1905, with J. G. Priestley[10], he published what I think he regarded as his most important single paper, showing that under normal conditions human breathing is so regulated as to keep the percentage of carbon dioxide in the alveolar air almost constant at atmospheric pressure. It was characteristic of Haldane that, before going into compressed air, he verified that the partial pressure remained steady when the density of the air changed, by descending a tin mine and ascending Ben Nevis. With Fitzgerald he established norms for men, women, boys and girls. His work in mines and textile factories prompted a series of experiments in which he showed that the main factors in determining human reaction to heat are wet-bulb temperature, air-flow, and clothing. This work has since been greatly extended by others.

He next investigated diving with A. E. Boycott and G. C. C. Damant, R.N.[11]. His first discovery was that the pumps used by the Navy to send down air to divers leaked atrociously even at four atmospheres. It was believed to be dangerous to ascend or descend at more than 1·5 m./min. The present record is about 60. There is no danger in rapid descent provided the air supply is adequate and the diver can hold his Eustachian tubes open. But Bert had shown that too quick an ascent can lead to the liberation of bubbles of nitrogen which may cause death from embolism, paralysis, pain and other symptoms. Experiments on goats showed that however long they had been kept at a given pressure it was safe to halve it. Simple calculations based on this fact and on the hypothesis that various tissues exchange nitrogen with the blood by simple diffusion at different rates, while the arterial blood is in equilibrium with the alveolar air, allowed the preparation of tables for decompression by stages; and these were tested, first on goats and then on men. In the subsequent fifty-two years these tables have needed very little alteration, though they have been extended to greater depths and longer times.

At this time he was also serving on Royal Commissions on the ventilation of factories, and on mines. Among the measures which he recommended, in the face of much opposition, were the provision of pit-head baths, and means for reversing the ventilation in coal mines. Both have since been made compulsory. A moment's consideration of the results of a fire near the down-cast shaft, when the air stream can be reversed and when it cannot, should make the value of reversal clear.

Meanwhile, in a series of papers, mainly with C. G. Douglas, he worked out the details of the regulation of breathing. Their results are summarized in "Respiration"[16], though a student of physiology may well read the original papers to see how the conclusions were reached. In 1911, with Douglas and two American colleagues, Yandell Henderson and E. C. Schneider, he spent six weeks at the summit of Pike's Peak (14,019 ft.) in the Rocky Mountains. They studied acclimatization, which included changes in the blood volume, increased hæmoglobin production, and a lowering of the plasma bicarbonate which permitted increased breathing. Their further conclusion, that the lungs secrete oxygen into the blood, has been denied by Barcroft and others; but it is not sure that the last word has yet been said about it. In 1912, he published a paper[12] with Douglas and myself on the equilibria between hæmoglobin, oxygen, and carbon monoxide, and the effects of carbon dioxide on them. In 1914, with Christiansen and Douglas[13] he confirmed, and above all quantified, Bohr's observation that the oxygenation of blood drives carbon dioxide out of it.

The outbreak of war in 1914 greatly slowed down his work. In April 1915 he was called out to France to advise on protection from chlorine. In a series of brief and drastic experiments on himself, Douglas, myself and others, he devised a respirator which could be made rapidly in large numbers, and gave partial protection. He insisted, however, that only a respirator of the box-type would be adequate. The generals, medical and other, concerned in the matter thought otherwise. The disaster of Loos, in September 1915, was the result. But he had been too frank in his criticism of senior officers, so after this his advice was only sought sporadically on protection against gas.

In 1916 he published a short paper with Priestley on kidney function, and in 1919 and 1920 several papers with Meakins, Kennaway and others, on oxygen-want produced by low pressures, shallow breathing, and other causes. His last contribution to physiological research was a paper in 1929 with Hancock and Williams on sweating; but during his latter years he published much important work on hygiene with special reference to ventilation. He died in 1936 of heart failure following pneumonia. The pathologist who, at his request, carried out a post-mortem examination, said that he had never seen a heart with so little conducting tissue. In 1900 he had been advised to live the life of an invalid on account of cardiac symptoms. Had he done so a good many miners, divers and soldiers would have died earlier than they did.

My father's philosophical views have been widely misunderstood. He rejected what he called materialism, which he defined as "the belief that physico-chemical realism, or the assumption that the representation of our surrounding universe by the physical sciences in their traditional form corresponds to reality, can be extended so as to cover, not only the phenomena of life, but also those of conscious behaviour". In youth he was an idealist, but later described himself as a realist. The following passages, written[15] during his last decade, show how he interpreted the physical discoveries of the present century. "An ultramicroscopic virus seems to represent a form of organism which may perhaps be of not more than molecular size. The study of so minute an organism may possibly furnish a link in the extension of biological interpretation into what we at present regard as the inorganic world of molecules and atoms. The discovery of quantum phenomena strongly suggests the possibility of such an extension, which must be regarded as one of the scientific aims of biology". "An atom seems to maintain intense co-ordinated internal specific activity, which does not become dissipated in its environment, and on which both its mass and its other properties depend.... Thus the assumed basic conceptions of the Newtonian physics have been shown not to be in reality basic; and we are presented instead with what seem to resemble in essential respects the facts which biological study forces on us". But he was not prepared to wait for physical discoveries. He took the fact of life as co-ordinated activity, as given.

He was perhaps even more opposed to vitalism. The following passage, referring to the allegedly complete compensation of the increased metabolic production of acids during pregnancy by increased breathing which lowers the level of carbon dioxide in the body, illustrates his objection. "But if the compensation were really perfect we should be landed in the position of the vitalists of assuming effects to be produced without any measurable cause. In reality the acidosis is not completely compensated, and the incompleteness is only hidden by the extreme roughness of the method of measurement in comparison with the fineness of the physiological reaction". A corollary of his rejection of vitalism was his disbelief in personal immortality, which he combined with a lively belief in God; his theological views were definite enough to prevent him from joining any religious organization.

Many contemporary physiologists thought in terms of mechanism, and did not see why he was not content with the notion that the mechanisms concerned were very numerous and delicate. They twitted him with making accurate physical and chemical measurements. In this article I have only referred to a few of his analytical methods; for these have often been superseded by more speedy and accurate ones, though sometimes by methods which are more expensive and no more reliable. His answer was as follows. "As a mere physicist or chemist I should never have dreamt of looking for such things as constant dissociation curves or carbon dioxide pressures or hydrogen-ion pressures or chlorine percentages in such liquids as blood; and if I had chanced to find one it would only have appeared as a very unintelligible fact". Even if (as I do not believe) his point of view is fundamentally false, it has great heuristic value.

To take a concrete example, Gemmill and Reeves, in 1933, working on dogs trained to breathe through respiratory valves, showed that the receptors for oxygen want are in the carotid sinus, but those for carbon dioxide excess are elsewhere, probably in the medulla. But Haldane, Meakins and Priestley[14] had found in 1919 that oxygen want mainly increases the frequency of human breathing, while carbon dioxide excess mainly increases its depth. Hence these two stimuli cannot act in summation on the same receptors, a fact ignored by many workers in the interval between the two papers cited. Even if the aim of physiology is regarded as a mere cataloguing of the functions of various organs, a study of the organism as a whole will tell physiologists what to look for.

Haldane's research was based on his beliefs in the unity of organisms as self-sustaining systems, and in the value of accurate measurements. If an organism is seriously damaged it may no longer be capable of self-regulation, and large and easily measurable changes may occur in it. But very great accuracy is often needed to measure the small changes which occur in healthy organisms, and which give the clue to their self-regulation. That is why he preferred to experiment on himself with an accurate apparatus rather than on rabbits with an inaccurate one.

At present biochemists are largely concerned with research which, on a molecular scale, is the equivalent of human and comparative anatomy on a larger scale. This work has been of immense practical value when, as with antibiotics and weed-killers, the desired end could be obtained by killing species *A* while sparing species *B*. It has been of much less value when, as in the therapy of cancer and psychosis, we desire to restore normal self-regulation within an organism.

I can perhaps best illustrate the value of my father's approach by citing the work of the two living biologists whose approach seems to me closest to his, though I doubt if they were directly influenced by him. Karl von Frisch discovered the system by which bees communicate the direction and distance of a

food source. He observed them under almost normal conditions, and investigated quantitatively the correspondence between the dance of a bee, the voyage which it had made, and those made by other bees which responded to the dance. He discovered that bees respond to the polarization of light. But this was first inferred from their behaviour under natural conditions. It was not discovered by measuring the response of isolated organs to physically well-defined stimuli. Jacques Monod and his colleagues studied the synthesis of β-galactosidase by bacteria under a variety of external and internal conditions. The results give no direct information as to the process of protein synthesis, such as are given by studies of enzymes which phosphorylate amino-acids. But they tell us enough about its regulation to offer at least a possible partial explanation of why different cells in the same organism make different proteins. The by-products of this work, such as Cohen and Cowie's production of bacteria in all the proteins of which selenomethionine completely replaces methionine, are as important as they are unexpected.

Haldane's approach to biology is not the only fruitful one. But I think that in most fields of biology it is not being applied as fully as it should be if research is to be as efficient as possible. However that may be, a study of his work and thought can still, I believe, be of great value in suggesting topics, and above all, methods, of research to biologists to-day.

[1] Carnelley, T., Haldane, J. S., and Anderson, A. M., *Phil. Trans. Roy. Soc.*, B, **178**, 161 (1887).
[2] Haldane, J. S., and Smith, J. L., *J. Path. Bact.*, **1**, 168, 318 (1893).
[3] Haldane, J. S., *J. Physiol.*, **18**, 430 (1895).
[4] Haldane, J. S., *J. Physiol.*, **22**, 298 (1898).
[5] Haldane, J. S., *J. Physiol.*, **22**, 465 (1898).
[6] Haldane, J. S., and Smith, J. L., *J. Physiol.*, **25**, 331 (1900).
[7] Haldane, J. S., *J. Physiol.*, **26**, 497 (1901).
[8] Boycott, A. E., and Haldane, J. S., *J. Hyg.*, **3**, 95, **4**, 73 (1903, 1904).
[9] Haldane, J. S., and Thomas, R. A., *Trans. Inst. Min. Metall.*, **12**, 1 (1903).
[10] Haldane, J. S., and Priestley, J. G., *J. Physiol.*, **25**, 331 (1905).
[11] Boycott, A. E., Damant, G. C. C., and Haldane, J. S., *J. Hyg.*, **8**, 445 (1908).
[12] Douglas, C. G., Haldane, J. S., and Haldane, J. B. S., *J. Physiol.*, **44**, 275 (1912).
[13] Christiansen, J., Douglas, C. G., and Haldane, J. S., *J. Physiol.*, **48**, 244 (1914).
[14] Haldane, J. S., Meakins, J. C., and Priestley, J. G., *J. Physiol.*, **52**, 420 (1919).
[15] Haldane, J. S., "The Philosophical Basis of Biology" (Hodder and Stoughton, London, 1930).
[16] Haldane, J. S., and Priestley, J. G., "Respiration" (Oxford Univ. Press, 1935).

NEW LABORATORY OF THE DEPARTMENT OF METALLURGY, UNIVERSITY OF OXFORD

MR. ISAAC WOLFSON officially opened the new Laboratory of the University Department of Metallurgy at Oxford on May 31. The building (Fig. 1) is the first section of the new science area of the Keble Road triangle, and it was designed by Mr. George Buzuk, of Messrs. Murray, Ward and Partners.

In a speech welcoming the visitors, Prof. W. Hume-Rothery, head of the Department, outlined the history of metallurgy in Oxford and expressed the Department's appreciation of the support received from many sources, and from Mr. Wolfson, whose endowment of the chair of metallurgy had supplied the crowning touch to the establishment of the subject.

Mr. Wolfson spoke of the increasing dependence of many branches of modern science, and of industry, on research in metallurgy. The small Oxford school, in spite of the scale on which it has been compelled to work, has played a prominent part in the scientific study and understanding of the subject. In the new building this work will continue, and the introduction of the teaching course will help to provide more of the trained metallurgists which Britain so urgently needs.

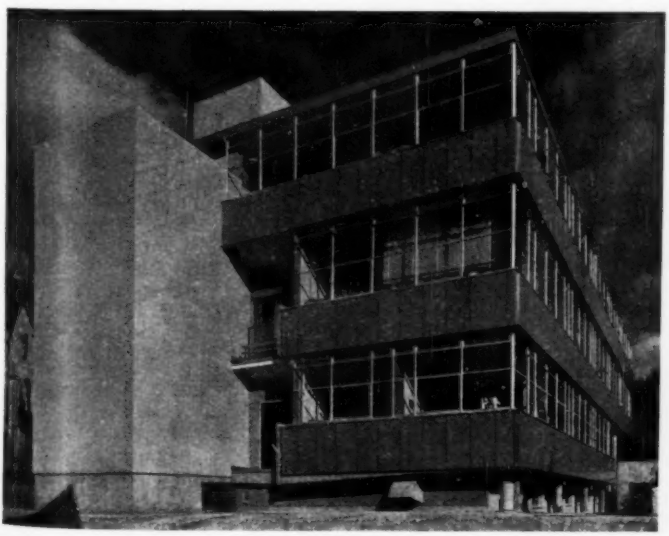

Fig. 1. Department of Metallurgy, University of Oxford. By courtesy of *The Architect and Building News*

The Vice-Chancellor of the University of Oxford, Mr. T. S. R. Boase, paid a tribute to Mr. Wolfson and his Trustees, who are one of those foundations that play such an immense part in the expansion of university life to-day. He described the building as the first unit of what will undoubtedly become the great centre of twentieth-century architecture in the Oxford of the future.

After the opening ceremony, the laboratories were open to inspection by the visitors, and the apparatus and results of some of the research in progress were displayed.

The new building has four floors: in the basement there is the main

workshop, the mechanical testing room, and the furnace room which is at present devoted to high-temperature research work. There are also two X-ray rooms, one of which is being used for high-temperature X-ray work.

On the ground floor are rooms devoted to electron microscopy, internal oxidation and precipitation hardening of alloys, high-temperature mechanical testing, and X-ray diffractometry. The first floor contains the main teaching laboratories, the microscope room and the library. The study rooms for the staff are on the top floor, together with rooms for work on the constitution of alloys, the thermal analysis of high-melting alloys, zone melting and electron bombardment techniques, grain boundary precipitation and the freezing of alloys, and mechanical properties of metals and alloys.

The builders were Messrs. Whittalls, Ltd., of Birmingham.

The opening of the new laboratory marks a further stage in the development which has proceeded gradually over the past thirty-five years. In 1922, Prof. F. Soddy proposed the establishment of metallurgy at Oxford and arranged for the present Isaac Wolfson professor, W. Hume-Rothery, to study metallography under Sir Harold Carpenter at the Royal School of Mines in London. Many difficulties had to be overcome, and the first appearance of metallurgy in Oxford in 1926 was on one bench of a room lent by Prof. W. H. Perkin on the ground floor of the Dyson Perrins Laboratory.

After a few years, a move was made to two rooms in the Old Chemistry Department, and it was here that Hume-Rothery, with one or two research students, worked for many years helping to establish some of the present theory of alloy structures. During this period, the subject was entirely postgraduate under Hume-Rothery, who held, in succession, the Armourers and Brasiers fellowship and a Warren Research fellowship of the Royal Society. Research was made possible by the continual interest and help received from Dr. N. V. Sidgwick and Sir Henry Tizard at Oxford, and Prof. C. H. Desch at Sheffield, and the National Physical Laboratory, together with research grants from the Royal Society, the Department of Scientific and Industrial Research and the British Non-Ferrous Metals Research Association. In 1937, C. N. (now Sir Cyril) Hinshelwood became Dr. Lee's professor of chemistry and, thanks to his guidance and steady support, metallurgy was gradually introduced in the official scientific circle at Oxford. Hume-Rothery became a lecturer in 1938, and held a fellowship by special election at Magdalen during 1938–43. Laboratory accommodation was expanded, and, during the War, work on the constitution of alloys was carried out for the Ministry of Supply. Lectures were given in the Chemistry School, but metallurgy as such remained a postgraduate subject until 1949, when metallography was recognized as an official supplementary subject and laboratory classes were introduced.

When the schemes for the expansion of the Inorganic Chemistry Laboratory were put forward, the first arrangements were for metallography to develop as a sub-department of that Laboratory. The independent expansion of metallurgy was first advanced in 1953, the initial suggestion coming apparently from Prof. (later Sir Francis) Simon. The idea was guided to a successful conclusion by the perseverance and skill of the then registrar, Sir Douglas Veale. The generosity of the Pressed Steel Company enabled the foundation of the George Kelley Readership in memory of its late managing director. The late Major A. Pam, of the Pressed Steel Co., was responsible for raising an industrial fund; this has contributed much towards the running of the Department, which became independent in 1956. Meanwhile, the University Grants Committee provided a grant for the building of the new Laboratory on the Keble Road triangle, and the establishment of the subject was completed by Mr. Isaac Wolfson's endowment of the chair of metallurgy in 1957, when Hume-Rothery, who had controlled the subject since 1926, was elected first Isaac Wolfson professor of metallurgy.

The present staff consists of the Isaac Wolfson professor, the George Kelley reader (Dr. J. W. Christian), two lecturers (Dr. J. W. Martin and Dr. S. L. Altmann) and a graduate assistant (Dr. A. Hellawell). An independent honours degree course was established in 1956, while metallography remains a supplementary subject which may be read by those whose main subject is in another branch of science.

The introduction of metallurgical research into Oxford under Hume-Rothery coincided with an exciting period in the history of the science of metals and alloys. In spite of extremely limited accommodation and numbers, the Oxford School made substantial additions to the theory of alloys. The early work was concerned mainly with alloys of copper, of silver, and of magnesium, but many conclusions applied to alloys of other metals. This work was later extended to alloys of aluminium, of iron, and of the high-melting transition alloys such as those of molybdenum which are becoming of increasing importance. Under the present George Kelley reader, the Oxford work spread into other fields of physical metallurgy, including phase transformations and mechanical properties. Contributions have been made to the theory of martensite, of stacking faults, and of the factors controlling the flow stress of metals and alloys. Dr. Martin has introduced the new techniques of electron microscopy, and has used these to study dispersion hardening of alloys, and is also investigating the high-temperature mechanical properties of alloys, and the fracture characteristics of uranium. Dr. Altmann, as a mathematical physicist, is investigating the theory of the band structure of metals, and Dr. Hellawell's work is concerned with the freezing of alloys and the structure of grain boundaries.

On the teaching side, the University now provides a four-year honours degree course in metallurgy. The metallurgical work, in which emphasis is placed on fundamental principles rather than technological processes, is combined with the full Oxford course in inorganic and physical chemistry. Written and practical papers in these three subjects are taken after three years, and constitute Part I of the final examination. The fourth year is spent on research in some topic related to metallurgical science, and the student submits a thesis and has an oral examination. The honours class is awarded on the combined results of Parts I and II.

In thirty-five years, metallurgy at Oxford has thus expanded from one bench in an organic chemistry laboratory to a laboratory of its own, which is equipped and staffed to deal both with purely theoretical investigations and with experimental work at temperatures ranging from 3,000° C. to that of liquid air, and this lower limit will soon be extended to within a few degrees of the absolute zero of temperature.

UNIVERSITY EDUCATION IN NEW ZEALAND

THE report of the Parry Committee on the New Zealand Universities* follows in many respects that of its predecessor, the Murray Report on the Australian Universities (see *Nature*, 181, 300; 1957). It does, however, right through its various sections, emphasize again and again the present more parlous condition of the New Zealand Universities. This condition has been "engendered by the alarming rate at which staff has been leaving, the inability to recruit new staff of adequate calibre because of low salary rates, the inadequacy of buildings and equipment, and the poor teaching conditions that, in large measure, stem from the high proportion of part-time students."

The Committee stresses that to fulfil their part "the Universities must play a much greater role in the New Zealand community, and must be much better supported financially than they have been in the past". One major difficulty has been that the New Zealand Universities have not been "widely regarded as having a primary responsibility for original investigation and research". If the report succeeds in changing this attitude within the country, it will have achieved a major success, and, provided the time, money and facilities become available, the staff should then be able "to think about the future of their society in relation to its past, to compare and relate the contributions of other cultures to those of their own, to investigate the nature of the physical world and to keep abreast of the investigations of others".

The report directs attention to the serious shortage of university graduates in New Zealand to meet the demands of a number of professions, of many sections of industry, commerce, education and of the public services. In particular, it concludes that a substantial increase in the number of science and engineering graduates will be required for many years to come. An analysis of figures given in the report shows that in 1962 there will be about 1,300 students graduating with bachelor's degrees, and that 2,440 will be wanted in post-primary teaching, agriculture, the Civil Service and universities alone, so that "all the evidence points to an acute shortage of the university-educated persons needed for the country's educational services and economic development". As the report points out, it is going to be essential in the future for the universities and potential employers to give more attention than they have in the past to assessing the probable future demands for people with university education and then preparing plans to meet them.

One reason for this acute shortage may be the high rate of failure among the students. There are those who believe that the entrance standards are too low and that accrediting should be replaced by examination; these people will be disappointed that there is no recommendation to change from accrediting to examination, even when an increase has taken place in the staff of the universities.

One recommendation, which will certainly be hotly debated, is that more of the better students from selected schools should be allowed to commence their university studies at the second-year level. This is already permitted in Greek and mathematics, but if it is extended it will be very difficult to eliminate later. It would surely be better, if the Government accepts the Committee's recommendations for increased staffing, to introduce pass and honours degrees. The University of Canterbury already has this system in the Science Faculty, and the Science Faculties of Victoria and Otago have just introduced it. Much could also be done by raising the standards in secondary schools, though this is naturally associated with the supply of graduates for the teaching profession. The Committee further considers that more could be done to reduce the rate of failure by providing extra assistance to students in coping with the transition from school to university.

The report refers to the fact that at present about 32 per cent of those passing university entrance examinations do not offer mathematics or a language, and that only 9 per cent offer both. Despite the importance of mathematics for a range of disciplines, more than 55 per cent of those passing entrance examinations do not offer the subject. This indicates that some changes, at least, are required in entrance requirements.

The Committee is adamant that the proportion (46 per cent) of part-time students (mostly in arts, law and commerce) is far too high, and that their rate of first-year failure of 60 per cent is also too high. It believes that the value of full-time study has not yet been sufficiently appreciated by students, parents, employers and the Government. It rightly recommends the transition to full-time study for as many students as possible, though this will automatically involve extra expenditure on bursaries and halls of residence.

The recommendations of the Committee on scholarships and bursaries are far-reaching. Many of the awards are at present too low and must be increased. Some of the awards, such as the bonded bursaries for teachers, are out of all proportion to other awards and the demands of the situation. Students who accept such bursaries commonly make a decision on their future vocation far too early in their university careers, and the recommendation to abolish the bonded bursaries should be welcomed by staff and students alike. Other important financial recommendations will enable more students to proceed to the degrees of master and doctor. For too long now students have been leaving New Zealand to study overseas, even though some departments are increasingly able to offer first-class postgraduate instruction. If the recommendations on staffing and research finance are met by the Government, there is no reason why New Zealand postgraduate training in all departments should not be the equal of any university in the Commonwealth.

The staffing position in the New Zealand Universities has reached an alarming condition, almost solely as a result of inadequate salaries. The Committee says that academic salaries must in future bear a relationship to those paid in Australia, since New Zealand has become an important source of

*Report of the Committee on New Zealand Universities. (Government Printer, Wellington, 1960.) 4s. 6d.

Australian recruitment. It has recommended a new scale: professors (£2,800), associate professors (£2,250), senior lecturers (£1,750–£2,000), lecturers (£1,250–£1,700), assistant lecturers (£900–£1,100), and it is gratifying to know that the Government has accepted this recommendation and implemented it as from April 1. This should stop further loss of teachers and enable the Universities to recruit first-class new staff. It will be essential, however, to keep salaries under review, especially if Australian university salaries continue to rise. It is to be hoped that these increases may also assist scientists in the Government service, who have also been leaving the country, to secure a rise in their salaries. The recommendations of the Committee on leave are not so definite. This is to be regretted, since past experience has shown that, in the absence of definite recommendations, there is likely to be a long period of protracted negotiation before there is any improvement in the terms of leave and the amount of travel grants. If the Government is prepared to accept the recommendations for extra technicians, library and administrative staff, this should be of great material assistance, especially to science departments, where technical assistance is at present grossly inadequate. The libraries also require much more money to make their collections of a size regarded as essential elsewhere. The recommendation of an immediate grant of £50,000 may well prove inadequate even when associated with the long-term proposals for improvement.

The report points out that university building in New Zealand is about five years behind schedule, and that when some of the buildings now being constructed are completed they will be over-crowded. The Committee believes that the present annual expenditure of £800,000 on buildings will have to be increased to £2 million over the next ten years, and further, that more will have to be done by the Government in providing halls of residence.

The encouragement and development of science and technology is vital to the well-being and economy of any country. These have, so far, been unduly neglected or not appreciated in New Zealand, especially in industry. The Universities have their part to play here, and the Committee recommends that much more of the applied sciences should be included in degree courses. It also implies that there is insufficient co-ordination of scientific research between the Universities and the Department of Scientific and Industrial Research. The latter has located a number of important departments (for example, the Soil Bureau and the Institute of Nuclear Research) in places distant from the universities, and there is no doubt that more co-ordination would benefit both the Universities and the Department. Science in the Universities should also receive a long overdue stimulant if the Government accepts the Committee's recommendation to increase the present research grant of £25,000 to £65,000 this year and £100,000 in 1961. Another notable recommendation is for the establishment of a National Scientific Research Council, which should overcome the present disproportionate expenditure on research between Government research institutions and the Universities, and the present lack of co-ordination.

The recommendations not to establish a veterinary school or a second school of medicine will certainly be unwelcome in some quarters in New Zealand, though the recommendation not to establish further teacher-training colleges away from the present universities will command general support.

The impending disappearance of the University of New Zealand, the coming autonomy of the constituent Universities and the implementation of the recommendations will require, the Committee reports, the re-organization and enlargement of the present University Grants Committee under a full-time chairman. Many, however, will not agree with the suggestion that only a minority of the members of the Committee should be drawn from the academic institutions. The proposal to retain the University Entrance Board may not commend itself to some, and the proposed constitution of five University and five Department of Education representatives under a chairman may well stultify its operations.

It is evident from the foregoing that the Committee has unerringly indicated the present difficult conditions prevailing in the New Zealand Universities. The recommendations it has made will, in nearly every case, if accepted, bring these Universities up to the point where their status will be equal to that of the best universities in the Commonwealth. If the Government of New Zealand, in conjunction with the University Senate, will act as promptly on the other recommendations as the Government has on the salary proposals, there should be little need for those concerned with higher education in New Zealand to fear the future, and the Universities should be able to play their full part in the further development of the country, its economy and social life. It will also give new heart to those among the present staff who have laboured, often under incredibly difficult conditions, to build departments worthy of recognition throughout the world.

V. J. Chapman

RADIOSTRONTIUM AND RADIOCÆSIUM IN MILK DURING 1959

By W. ANDERSON, L. K. BURTON and J. O. CROOKALL

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It is clear from a number of reports[1–3] that the concentration of long-lived fission products (strontium-90, cæsium-137) in rain falling over Great Britain was substantially higher during the first half of 1959 than during any previous half-yearly period. In consequence, the rate of fall-out during this period was comparatively high, and, as shown recently[4], the levels of strontium-90 in milk sampled widely in Great Britain rose during the period April–June 1959 to values which were generally higher (by a factor of the order of 1·5) than the peak-levels during 1958. It has also been noted[5] that the levels of strontium-90 in human bone formed during the early part of 1959 showed a significant increase when

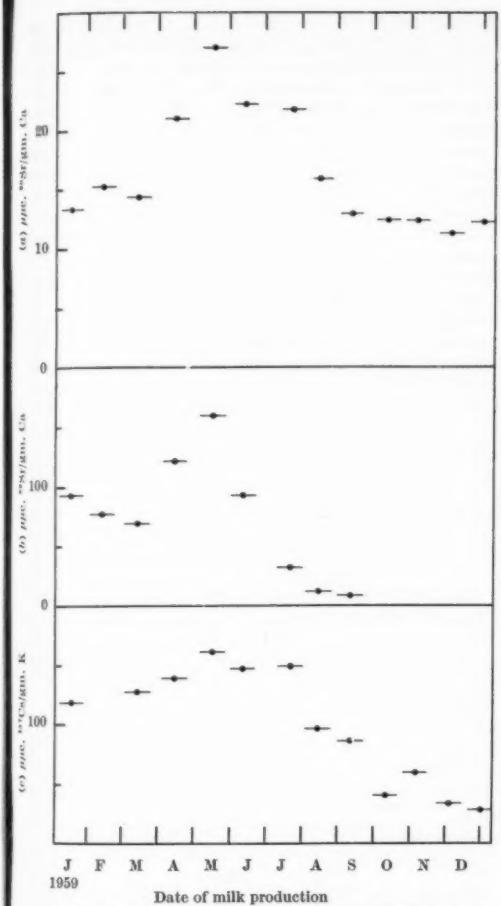


Fig. 1. Levels of fission products in milk from Felinfach, west Cardiganshire, Wales (1959)

compared with earlier levels. We report here the values found for strontium-90, strontium-89 and cæsium-137 in milk samples produced at Felinfach Creamery in west Cardiganshire, Wales, throughout 1959, and we compare these results with those already described for samples of the same series during 1957–58[6,7]. As before, the samples were received at weekly intervals and measurements made on bulked samples, compounded from four consecutive weekly samples. The values obtained for 1959 are shown in Fig. 1.

In our previous report[7], we showed that the average level (15·7 strontium units) of strontium-90 in milk produced at Felinfach during May–August 1958 was 2·2 times the corresponding level (7·0 strontium units) in milk derived from neighbouring pastures (Carmarthen) during May–August 1957 (1 strontium unit = 1 μμc./gm. calcium). A comparison of the average level (21·4 strontium units; Fig. 1) for May–August 1959 with that for the same period of 1958 shows that a further increase occurred in the levels of strontium-90 present in the pastures of this region between 1958 and 1959 (× 1·36).

The 1959 increase of strontium-90 in milk may be due partly to an increased rate of fall-out and partly to an increase in the soil reservoir of strontium-90. The strontium-89/strontium-90 ratios in the milk (from Fig. 1) during the months May–August are on the average 62 per cent of the corresponding ratios in rain falling during the same months[3]. This result is similar to the figure (70 per cent) found for 1958 and it again indicates that a substantial fraction of the activity in the milk was derived from material deposited at or near to the time of milk production. It may be noted that the strontium-89 levels in both milk and rain-water fell sharply over the period May–August 1959 and we have not measured this nuclide in samples collected after that time.

It is useful to compare the 1958 and 1959 rates of fall-out. Estimates of the amount of strontium-90 deposited over the Felinfach–Carmarthen region for successive May–August periods give a 1959/1958 ratio ≃ 0·9 (estimates based on meteorological and fall-out data[1,3]). This fall-out ratio is, in fact, somewhat lower than the corresponding ratio (1·36) for strontium-90 in milk. It should be noted, however, that the deposition of strontium-90 in the region was notably high during April 1959, and the (April–August 1959)/(April–August 1958) fall-out ratio was 1·3. To account for the 1959 increase of strontium-90 in milk, by relating it to an increased fall-out rate, it is therefore necessary to assume that the levels in milk during a given month were influenced by the deposition-rate of the immediately preceding month. This appears to be a reasonable assumption since some integration of activity will occur in the herbage before grazing takes place. In fact, a comparison of the fall-out and milk activity-levels for the open pasture feeding period May–October 1959 indicates that, during this period, the changes which occurred in the milk between any two successive months reflected changes which had occurred in fall-out rate between the two immediately preceding months (Fig. 2).

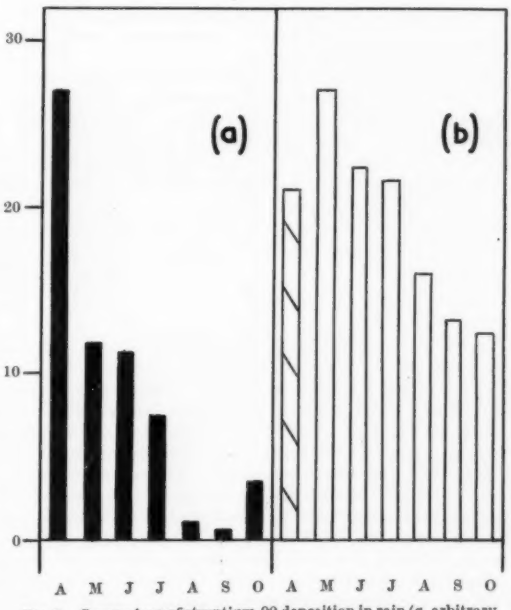


Fig. 2. Comparison of strontium-90 deposition in rain (*a*, arbitrary units) with levels in milk (*b*, strontium units) (Felinfach, 1959). The milk-level during April partly reflects the activity present in winter fodder

It is not possible to define precisely what contribution is made to the milk activity from the strontium-90 in the soil reservoir, since the characteristics of this reservoir, particularly the availability of the activity, are not well known. The contribution from this source clearly becomes more important during periods when the rate of fall-out, and the activity levels in milk, are relatively low. This appears to be reflected at the end of the 1959 open pasture feeding period (Fig. 2) when the activity levels in milk are relatively insensitive to the fall-out rate changes. In our previous report[7], we showed that up to 5·5 strontium units in milk sampled at mid-1958 might be derived from the strontium-90 accumulated in the soil up to that time. The corresponding figure for 1959 is 8·3 strontium units (based on a comparison of cumulative deposition at mid-1959 with that at mid-1958[1]). From this it appears that up to 50 per cent of the rise of strontium-90 in milk between 1958 and 1959 might be ascribed to an increase in the total strontium-90 accumulated on the ground.

As before[7], the trend of cæsium-137 levels in the milk (Fig. 1c) is essentially parallel to that for strontium-90, although there is some indication that the fall in cæsium-137 levels after May 1959 is significantly steeper than that for strontium-90. The cæsium-137 (μμc./l.)/strontium-90 (μμc./l.) ratio for May–August 1959, 8·6, is somewhat lower than the corresponding ratio, 10·0, for the same period of 1958. At the end of 1959 the ratio has decreased further (average for September–November 1959 = 6·5, December = 3·1). These results suggest that in the case of cæsium-137 the fraction of milk activity derived from the soil reservoir may be relatively less important than in the case of strontium-90. It may be noted that the cæsium-137 level in the milk at December 1959 (30 μμc./gm. potassium) is the lowest value yet recorded in our Felinfach series, which covers samples collected during 1956–59 (max. value = 160 μμc./gm. potassium, at May 1959).

The significance of the arguments presented above lies in their bearing on the prognosis of the future trend of fission product levels in milk. Assuming that there is no large-scale resumption of weapons testing, and that the 1960 rainfall will be near (or less than) average, an estimate based on current theory[8] of fall-out mechanisms suggests that the average rate of strontium-90 fall-out during March–August 1960 will be somewhat less than half that during the same period of 1959. Similarly, the total strontium-90 accumulated on the ground in the Felinfach–Carmarthen region at mid-1960 would not be expected to rise to more than 1·2 times the value at mid-1959. On this basis, the figure noted above (8·3 strontium units) as the mid-1959 upper limit for milk activity derived from the total soil reservoir becomes 10·0 strontium units at mid-1960. Likewise, the component which depends on the rate of fall-out is expected to be less than $0{\cdot}5 \times (21{\cdot}4 - 8{\cdot}3)$ strontium units = 6·6 strontium units at mid-1960. This treatment suggests that the mid-1960 strontium-90 level in milk from this region will be less than 16·6 strontium units, that is, less than three quarters of the mid-1959 value. The corresponding figure for cæsium-137, based on the cæsium-137/strontium-90 ratio (6·5) at the end of the open pasture feeding period of 1959, is 80 μμc./gm. potassium.

It should be noted that the figures presented above refer to levels in milk from a single region and they should not be taken to represent the average values for Britain as a whole. The trend of the strontium-90 levels is, however, broadly consistent with the country-wide picture so far described[4]. In view of the outstanding importance of the contribution from milk to the levels of activity which occur in human bone, the above prediction of a downward trend in milk activity suggests that the future trend of strontium-90 levels in newly formed bone should also be downward.

We are indebted to Prof. W. V. Mayneord, in whose Department the work was carried out, for his constant guidance and encouragement.

[1] Crooks, R. N., Osmond, R. G. D., Owers, M. J., and Fisher, E. M. R., Atomic Energy Research Establishment, Harwell, *R* 3094 (1959).
[2] Peirson, D. H., Crooks, R. N., and Fisher, E. M. R., *Nature*, **184**, 224 (1960).
[3] Anderson, W., Bentley, R. E., Burton, L. K., Crookall, J. O., and Greatorex, C. A., *Nature* (in the press).
[4] "Strontium-90 in Milk and Agricultural Materials in the United Kingdom 1958–1959", Agricultural Research Council (H.M. Stationery Office, London, 1960).
[5] Arden, J. W., Bryant, F. J., Henderson, E. H., Lloyd, G. D., and Morton, A. G., Atomic Energy Research Establishment, Harwell, *R* 3246 (1960).
[6] Mayneord, W. V., Anderson, W., Bentley, R. E., Burton, L. K., Crookall, J. O., and Trott, N. G., *Nature*, **182**, 1473 (1958).
[7] Anderson, W., Burton, L. K., and Crookall, J. O., *Nature*, **184**, 89 (1959).

OBITUARIES

Prof. John F. Fulton

Prof. John F. Fulton, who died on May 29, was the son of John Farquhar and Edith Stanley Fulton, and was born at St. Paul, Minnesota, on November 1, 1899, going later to Harvard and graduating there as M.S. in 1921. He was selected as a Rhodes Scholar and had the good fortune to be accepted by Magdalen College, Oxford, where he graduated B.A. with first-class honours in 1923, being in the same group as Howard Florey, later to become internationally well known for his work on penicillin. Fulton, at about this time, was extremely good-looking, as a photograph taken in 1932 shows. He became a University demonstrator in physiology under Sir Charles Sherrington, and in 1925 had already reached his twenty-seventh publication in journals. Sir William Osler had died in 1919, but the very wonderful Lady Osler still regarded her home at 13 Norham Gardens, Oxford, as a centre for the young, and she and Lady "Sherrie" were two on whom one never failed to call, usually on Sundays at tea-time, every term. Fulton helped to catalogue "Bibliotheca Osleriana", which was finally published in 1929; but before that, with the M.A. and D.Phil. Oxon. to his credit, he returned for a while to Harvard, where he took his M.D. in 1927. As assistant neurological surgeon at the Peter Bent Brigham Hospital, he worked under the master neuro-surgeon, Harvey Cushing, and he became in succession his pupil, close friend and, later, biographer.

As a Fellow of Magdalen he continued research in neurophysiology during 1928–30, and then in 1931

he was appointed to the Sterling chair of physiology at Yale, where one of his first decisions was to name his new home the 'Laboratory' rather than the 'Department' of Physiology. Many came to him from outside, attracted, as *The Times* obituary notice of him stated, by his breadth of outlook, humanistic approach, and personal example, his own interests being mainly electrophysiological, electro-cardiographic, and endocrinological, with the physiology of aviation becoming an outstanding fourth during the Second World War.

In Oxford he had married Lucia Pickering Wheatland, and in 1956 there was a reception in the History of Medicine Library at Yale to mark his total of twenty-five years of service in the Laboratory of Physiology and in the Department of the History of Medicine. Fulton was given a bound copy of a special issue of the *Yale Journal of Biology and Medicine*, and a silver medal which his friends had inscribed to him as physiologist, teacher and humanist.

In 1959, on his sixtieth birthday, friends met again, this time at his home at Mill Rock, to be presented with copies of "The Making of a Library", in the letters on which it was based being one from Arnold C. Klebs which quoted :

"Grau ist alle Theorie
Und grün der goldne Baum des Lebens",

and in which he stated that he believed in loving the old authors when they had something lovable. Wilmarth S. Lewis briefly said that Dr. Fulton alone survived of the three friends (Harvey Cushing, Klebs and Fulton) who brought the Historical Library to Yale, and that November 1, 1959, was a moment of congratulation and thankfulness : of thankfulness for Fulton's restored health, and of congratulation on his being only sixty, with years more of discovery and instruction before him. Elizabeth Thomson, who with Madeline Stanton was responsible for most of the planning of the reception, wrote to me that Mrs. Fulton was meeting guests at the top of the steps looking lovely and giving no hint of the strain of arranging a party of seventy *sub rosa*. However, Fulton found everything a real surprise and he was simply delighted with the book.

For myself I am indebted to him for countless kindnesses over the years, including the period after the First World War, and I am truly sorry that I am not to greet him in person at the tercentenary of the Royal Society, and at the centenary of the National Hospitals for Nervous Diseases. He would, I know, have entered with zest into both occasions.

KENNETH J. FRANKLIN

Dr. S. F. Birch

STANLEY FRANCIS BIRCH was born in November 1899 at Pewsey in Wiltshire, and was educated at Hurstpierpoint College and St. Paul's School, before going to the Imperial College of Science and Technology, whence he graduated. Working with Prof. J. F. Thorpe, he obtained the degree of doctor of philosophy for research work on three-carbon tautomerism, after which he joined the staff of the (then) Anglo Persian Oil Company, with which he was to spend the whole of his working life.

His great interest was in research connected with organic chemistry, and it was in this sphere that, in 1923, he commenced his career. Under Dr. A. E. Dunstan and with a small band of scientists, he worked in a country house at Sunbury-on-Thames ; these premises he was to see develop into the Research Centre of the British Petroleum Co., Ltd. An investigation of the malodorous components of the lighter fractions from Persian crude oils led to the identification of mercaptans and from this discovery stemmed a major research effort, concerning the nature and properties of sulphur compounds in petroleum, which he continued, with some interruptions, for the next thirty-five years. In this field he was regarded as an authority, and he published numerous scientific papers and gave many lectures both in Britain and the United States. He visited the latter country many times and was well known in many industrial research centres, universities and organizations connected with the American Petroleum Institute and American Chemical Society, of which he was a member.

The study of the reactions of hydrocarbons was, however, a branch of chemistry in which he made signal contributions to the petroleum industry. This work had, as its major achievement, the discovery of the sulphuric acid alkylation process in 1936 which, together with processes resulting from the determination of the octane numbers of pure hydrocarbons, and studies of the fractionation of petroleum distillates, formed the basis of the supply, by the Abadan refinery, of vast quantities of aviation spirit during the Second World War. His researches connected with the reactions of hydrocarbons made him realize, from a very early date, the potentialities of the petroleum chemical industry, and at his death on March 25 he held the position of research associate in the Petroleum Chemicals Department.

Birch believed very strongly that research could only be directed by those in close contact with the practical operations and that most discoveries came about as a result of critical observation and experimental skill. Until the last three years of his career, when administrative duties forced him, reluctantly, to move, he occupied an office situated close to the laboratories and was a frequent visitor to the bench where many informal technical discussions took place. 'Bill', as he was known to his friends, had wide-ranging interests apart from his research work. He was keenly interested in the theatre and ballet and antique works of art, and many of his leisure hours were spent building electronic and other gadgets.

He died on March 25, and is survived by his wife, Hilda Mary, whom he married on June 24, 1925. His many friends will sadly miss the pleasure of his company and the stimulation of his personality.

R. A. DEAN

Dr. J. H. Oliver

ON June 1 James Herbert Oliver died suddenly in Ankara. He had undertaken a visit to Ceylon and India and was returning to Britain by way of Turkey, where, in pursuance of a life-long interest, he was proposing to study native barleys.

Born in Portsmouth in 1901, he was educated at St. John's College, Southsea, and the Municipal College, Portsmouth, and after a period of private study he graduated in 1920. His first post was at the Olympia Agricultural Research Station near Leamington, where he worked under Dr. Herbert Hunter, who was widely known for the production of the brewers' barleys, Spratt Archer and Plumage Archer. It was here that Oliver developed the interest that he followed so assiduously throughout

his life. Returning to Portsmouth after the closing of the Research Station at Leamington, Oliver obtained a Salters fellowship and went to London to read for a doctorate at the Imperial College of Science; he entered into the full life of the times and rowed for his College.

In 1924 Dr. Oliver joined the firm of Briant and Harman, brewing consultants in the City of London, and three years later was offered a partnership. He eventually became recognized all over the world as the most authoritative consultant to the brewing industry in Britain and represented Great Britain on the Analysis Committee of the European Brewery Convention in 1947.

After the Second World War, Dr. Oliver developed an interest in the chemistry of the sea, with particular regard to its phosphate, nitrate and iron content, and he maintained a private laboratory at Hayling Island for this work. His researches in this field led him to the conclusion that coastal mud and sand become an important reservoir for these nutrients, which are distributed during times of storm and gale.

Dr. Oliver was a member of the Salters' Company, honorary hydrologist to the Zoological Society, and a member of the Challenger Society, whose meetings frequently were enlivened by erudite contributions delivered with a refreshing humour. He was a tireless and inventive worker, always striving to improve his apparatus or to increase the accuracy of his results. His energy and enthusiasm were infectious, and he was ever ready to lay aside his own work to help others. Over all his life there pervaded an ebullient and generous personality. He enjoyed life to the full because he had come to terms with it—his terms. He was a gracious and charming friend, and he will be sorely missed by all who had the good fortune to know him.

N. Ingram Hendey

NEWS and VIEWS

New Foreign Members of the Royal Society

Prof. G. Beadle

Prof. George Beadle's recent election to foreign membership of the Royal Society will give pleasure to many. Already a familiar name to cytologists and geneticists, especially for his work on maize and that with Ephrussi on eye transplants in *Drosophila*, he became one of the famous names in the history of biology when, in collaboration with Prof. E. L. Tatum, he established the possibility of studying the genetics of vital biochemical syntheses using *Neurospora* as material. This was the work for which Beadle and Tatum shared part of the Nobel Prize for Physiology in 1958. There had been biochemical genetics before. In fact, the concept that genes controlled biochemical synthesis followed clearly from the work of Garrod in man, and that of Haldane, Scott-Moncrieff and Lawrence on flower colours. But the *Neurospora* work provided a new kind of material, both in the sense that it was far more easily and quickly handled, and, most important, because it permitted study of the biochemical effects of genes that affect the vital metabolic processes of organisms, for the deficiencies could be made good by supplying appropriate metabolites externally. This work, incidentally, provides a strong argument against those who maintain that genetics only involves insignificant variation of organisms and that the really important evolutionary changes are inherited in some way that Mendelian techniques cannot investigate. But its important result is that it has led to the knowledge of the relation between genes and proteins that we have to-day, and is a direct ancestor of the exciting developments that are now the forefront of progress of biological knowledge and are coming to be called 'molecular biology'. Prof. Beadle was recently in Britain and gave the first Mendel Lecture of the Genetical Society.

Prof. Ragnar Granit

Prof. Ragnar Granit is professor and director of the Nobel Institute for Neurophysiology at the Royal Caroline Institute in Stockholm. Earlier in his career he worked in Sir Charles Sherrington's laboratory in Oxford, and it seemed appropriate, and a measure of the great honour in which he is held by physiologists, that he should have been chosen in 1954 to deliver the Silliman Memorial Lectures, exactly fifty years after the delivery by Sherrington of the classical series published as "The Integrative Action of the Nervous System". Granit's researches in sensory physiology have explored the relationship between sense organs and the nerve centres into which they send signals, and which, in turn, exercise centrifugal control over receptor sensitivity. In 1947 he published an important book, "Sensory Mechanisms of the Retina". The retina offered him a central nervous structure, uniquely accessible to stimulation by the natural and selective agency, in which the interplay of excitation and inhibition could be studied. More recently, he has found that the sensitivity of the retina can be modified by signals sent out to it from the brain. Newer work in his laboratory has extended his general approach to sensory problems to the special case of muscle receptors. This work has shown that these receptors are under the control of the central nervous system, and that such control can drive the motor nerve cells of the spinal cord servo-fashion over the muscle reflex arcs. The bold conception of a balance between direct control and servo-control of muscle is a typical product of Granit's imaginative insight, and is likely to stimulate research into the physiology of posture and movement for many years to come.

Prof. G. B. Kistiakowsky

The announcement of the election of Prof. G. B. Kistiakowsky as a foreign member of the Royal Society will have given great pleasure to physical chemists everywhere and especially to those interested in reaction kinetics. He was born and received his school education in Kiev, but his lifelong interests were probably shaped during his research student days in Berlin which, in the 1920's, was surely the world centre of the maturing science of physical chemistry and which has been the seminary of so many distinguished workers in this field. In 1926, Dr. Kistiakowsky went to Princeton and in 1930 he migrated to Harvard. From his pen have come numerous accounts of investigations which have always been marked by an elegance in conception,

execution and interpretation which is unmistakably his. He gave resonance quantitative significance by his measurements of heats of hydrogenation of unsaturated compounds; with Gomer, he was the first to measure the rate of combination of methyl radicals; he has developed methods for studying very fast reactions and, latterly, by his studies of the reactivity of photochemically produced methylene-type radicals, directed attention to fundamental problems of rate-theory. Light, spectrometers, shock tubes, mass-spectrometers and explosives—the tyrants of many chemists—have been his slaves. He has also been a great public servant in the United States in war and in peace, which fact has been recognized by many awards and has culminated in his present appointment as scientific adviser to President Eisenhower. These are but a few of his accomplishments, to which one must add his consummate skill in making quartz spiral gauges, as a skier, and raconteur, which, with his vivacity and friendliness, have made him so warmly regarded by students and colleagues from the United States and overseas.

Academician L. D. Landau

Academician L. D. Landau, who has been elected to foreign membership of the Royal Society, is a theoretical physicist with interests in all basic problems of physics regardless of the particular special field in which they arrive. His best-known work includes the theory of the diamagnetism of free electrons, the theory of transitions in atomic collisions, liquid helium, the divergence problems in quantum field theory. He has inspired and trained many distinguished pupils, and the series of text-books on theoretical physics written by him with E. M. Lifshitz on the basis of his lecture courses have had a profound influence on teaching in the U.S.S.R. He approaches physics with a very personal style, as impatient of pedantic purism as of slipshod physical argument. After working in Leningrad and Kharkov, he has now for many years held a professorship at the Institute of Physical Problems in Moscow.

Marshall Chair of the Physiology of Reproduction, Cambridge: Dr. A. S. Parkes, C.B.E., F.R.S.

Dr. A. S. Parkes, whose appointment to the newly established Marshall chair of the physiology of reproduction in the University of Cambridge has recently been announced, has worked for nearly thirty years in the National Institute for Medical Research, where he is head of the Division of Experimental Biology. Before joining the scientific staff of the Medical Research Council, Dr. Parkes had held a Beit Memorial Fellowship and a Royal Society Foulerton Studentship, and he had, at an early age, established himself as a leading investigator of the physiology of reproduction. His first interest was in ovarian function, knowledge of which was much advanced by his work; in later researches he contributed to most aspects of the physiology of sex hormones. In recent years he has paid much attention to the effects of cold on cells, tissues and the whole animal and, in collaboration particularly with Dr. Audrey Smith and Dr. C. Polge, he has made remarkable observations in this branch of biology. Dr. Parkes has always been alive to the practical applications of his researches; to him is due the method of administration of steroid hormones by tablet implantation, and the work on hypothermia has led to important developments in the storage of erythrocytes, of spermatozoa and of tissues for grafting. Apart from his laboratory researches, Dr. Parkes is keenly interested in world population problems. It is indeed appropriate that he should be the first to occupy a chair that bears the name of his former teacher, and which will give him the opportunity to develop a university department devoted to an important branch of physiology.

Educational Co-operation in the Commonwealth

In a written answer to a question in the House of Commons on June 24, Mr. R. Thompson, replying for the Minister of State for Commonwealth Relations regarding progress with plans for the award of scholarships under the Commonwealth Scholarship and Fellowship Plan, gave the following information from the Association of Universities of the British Commonwealth. Canada proposes to make ten scholarships tenable from October 1960 and twenty nominations from the United Kingdom have been requested. Offers of scholarships, tenable from March 1961, for study in Australia have now been made of Commonwealth countries and twenty-five nominations requested from the United Kingdom. New Zealand has announced the offer to other Commonwealth countries of twenty-six scholarships and fellowships tenable at any one time and up to five nominations for scholarships tenable from March 1961 have been requested from the United Kingdom. India has announced the offer of forty-five scholarships and fellowships to various countries of the Commonwealth, and the Federation of Malaya has offered postgraduate awards to more than ten Commonwealth countries, including the United Kingdom, tenable from May 1961. The Federation of Rhodesia and Nyasaland is offering about five post-graduate scholarships, visiting fellowships and mature awards tenable from January 1961, and the East African Governments have offered two scholarships, tenable at Makerere College, for which nominations have been requested from the United Kingdom. Pakistan, Ghana and Ceylon also announced offers of scholarships at the Commonwealth Education Conference, but no details are yet available. South Africa had offered a total of twenty scholarships tenable at any one time and five nominations from the United Kingdom had been requested. The Association of Universities of the British Commonwealth proposes to publish a full report of the work done under the Plan at the end of the first year of operation.

Advisory Committee on Nuclear Safety

An Advisory Committee on Nuclear Safety has been appointed "To advise the Minister of Power and the Secretary of State for Scotland on any matters affecting the functions of those Ministers in relation to safety under the Nuclear Installations (Licensing and Insurance) Act, 1959, which may be referred to them by either of those Ministers or which in the Committee's opinion ought to be brought to the notice of either Minister, apart from any such reference". Its membership is as follows: Sir Alexander Fleck (*chairman*); Dr. T. E. Allibone, director of the Associated Electrical Industries Research Laboratory, Aldermaston; Mr. G. F. Bullock, general manager, Vulcan Boiler and General Insurance Co., Ltd., Manchester; Sir John Cockcroft, Master of Churchill College, Cambridge; Mr. Patrick Connor, Scottish Divisional Officer of the Amalgamated Engineering Union; Dr. S. C.

Curran, principal of the Royal College of Science and Technology, Glasgow; Prof. P. I. Dee, professor of natural philosophy, University of Glasgow; Prof. J. Diamond, professor of mechanical engineering, University of Manchester; Mr. P. T. Fletcher, deputy managing director, Atomic Energy Authority, Development and Engineering Group, Risley; Prof. J. E. Harris, professor of zoology, University of Bristol; Mr. F. Hayday, member of the National Union of General and Municipal Workers and of the T.U.C. General Council; Sir Willis Jackson, director of Research and Education, Associated Electrical Industries (Manchester), Ltd.; Major-General S. W. Joslin, H.M. chief inspector of nuclear installations; Prof. J. M. Kay, professor of nuclear power, Imperial College of Science and Technology, University of London; Dr. John Loutit, director of the Medical Research Council Radiobiological Research Unit, Harwell; Mr. T. W. McCullough, H.M. Chief Inspector of Factories; Dr. A. S. McLean, director, Health and Safety Branch, Atomic Energy Authority; Sir George McNaughton, lately chief engineer, Ministry of Housing and Local Government; Mr. R. E. Newell, managing director, Imperial Chemical Industries, Ltd., Wilton Works, Middlesbrough, Yorkshire; Mr. H. N. Pemberton, chief surveyor to Lloyd's Register; Colonel G. W. Raby, managing director of Atomic Power Constructions, Ltd.; Mr. L. Rotherham, member for research of the Central Electricity Generating Board; Sir William Slater, Agricultural Research Council; Dr. F. A. Vick, deputy director, Atomic Energy Research Establishment, Harwell.

Agricultural Pest Control and Wild-life

The National Academy of Sciences–National Research Council has announced the formation of a Committee to investigate the relationship between chemical control of agricultural pests and conservation of America's wild-life populations. The creation of the Committee, which will function within the Division of Biology and Agriculture, is the most recent of several steps taken by the Academy–Research Council during the past few years in response to concern expressed in several quarters over use of chemicals to control agricultural pests. The members of the Committee are: Dr. Ira L. Baldwin, special assistant to the president of the University of Wisconsin (chairman); Dr. Ira N. Gabrielson, president of the Wildlife Management Institute; Dr. Tom H. Gill, executive director of the Charles Lathrop Pack Forestry Foundation; Dr. George L. McNew, managing director of the Boyce Thompson Institute; Prof. E. C. Young, professor of economics and dean of the graduate school, Purdue University; and Dr. G. C. Decker, entomologist, Illinois Natural History Survey. Dr. W. H. Larrimer, of the Academy–Research Council, will serve as the executive secretary of the Committee.

The Royal Anthropological Institute: Awards

The following awards were made at the annual general meeting of the Royal Anthropological Institute of Great Britain and Ireland: *The Huxley Memorial Medal for* 1961, to Dr. A. E. Mourant, director of the Blood Group Reference Laboratory, Lister Institute; this Medal is the highest award that can be made to an anthropologist, and has been awarded annually by the Council of the Institute since 1900; *The Rivers Memorial Medal*, for anthropological field work, to Prof. J. C. Mitchell (University College of Salisbury, Southern Rhodesia); the *Wellcome Medal of the Institute for* 1959, jointly to Mrs. E. M. Chilver, director of the Institute of Commonwealth Studies, Oxford, and Dr. P. Kaberry (University College, London).

At the same meeting officers of the Institute for the session 1960–61 were elected as follows: *President*, Dr. Audrey I. Richards; *Vice-Presidents*, Dr. G. Caton Thompson, Prof. M. Fortes, Mr. I. M. Sieff; *Honorary Secretary*, Dr. Marian W. Smith; *Honorary Treasurer*, Sir George Beresford-Stooke; and *Honorary Editors*, Mr. G. W. B. Huntingford and Mr. W. B. Fagg.

Zebra: a New Zero Energy Reactor

The United Kingdom Atomic Energy Authority has decided to build a zero energy fast reactor at the Atomic Energy Establishment, Winfrith. The reactor has been named *Zebra* (zero energy breeder reactor assembly). The reactor has been designed to permit the study of the neutron physics of a wide variety of fuel assemblies containing uranium and plutonium. The assemblies under study will be built up by loading fuel elements into a steel matrix (approximately a cube of side 10 ft.). The fuel elements contain both fuel plates and plates of neutron-absorbing material: the latter will be used to simulate the nuclear properties of the coolant and structure material which would be required in a power reactor. *Zebra* will be operated at room temperature and the heat output from the nuclear reactions in the core will be kept very low so that no cooling system is necessary. It is planned to commission the zero energy reactor during 1962. *Zebra* will be used to obtain information that will be needed for the design of a prototype which is likely to be the next step in the development of the fast reactor by the Authority. The work at Winfrith will complement that carried out at the Dounreay Experimental Reactor Establishment.

The Diploma in Mathematics

The Mathematical Association has now set up an Examinations Board to award a Diploma in Mathematics (Dip. Maths.). The printed regulations are to be available in the early autumn of this year, and it is expected that the first examination will be held at local centres in the British Isles in November 1961. The Diploma is intended for teachers who have not had the opportunity of reading for a degree which includes mathematics. Considerable interest in the proposal has been shown by the teacher-training colleges, the students of which might take the examination soon after completing their three-year course if they have taken mathematics as a special subject. Many of the technical colleges contemplate establishing part-time courses designed as a preparation for this Diploma.

A draft syllabus is now available from the Secretary of the Association at 29 Gordon Square, W.C.1. The examination will consist of four papers covering three separate schemes of work, and candidates will be required to pass in all sections, though reference on one occasion will be allowed in any one section. The first two papers are in pure mathematics, and these will form the core of the Diploma. The standard expected is that which might be reached by about a year of full-time study beyond the Advanced Level of the General Certificate of Education. The second section deals with mechanics and statistics. In this part, bearing in mind the special needs of women students, many of whom do none of this work at

school, the standard will lie part-way between Ordinary and Advanced Level. It is regarded as essential that anyone teaching mathematics at any stage should have some competence in this part of the work. An interesting (and perhaps controversial) section is the third, which deals with the history and ideas of mathematics. Detailed history will not be required, but candidates will be expected to have a clear understanding of the origin and development of the various subjects and topics up to the end of the seventeenth century, with some awareness of subsequent developments. The purpose of the paper is to ensure that teachers will be able to illustrate and enliven their lessons by passing comment, or even by digression, about the great names and the fruitful periods in the subject. This could ensure that mathematics lessons of the future would cease to be, what they so often are to-day, a sequence of mechanical processes.

Radio and Electronics Engineering

THE Education Committee of the British Institution of Radio Engineers has prepared a report on the education and training of the professional radio and electronics engineer (Pp. ii+31. London: British Institution of Radio Engineers, 1960). The report defines the field of radio and electronics, and considers the qualifications required for professional competence in this field. After a brief reference to the Institution's own examination, the relevant educational facilities in universities, colleges of advanced technology and technical colleges are reviewed in some detail. Consideration is given to the radio and electronics content of university degree courses in physics and electrical engineering, in diploma in technology courses in applied physics and electrical engineering, and in courses for higher national diplomas and higher national certificates with endorsements. Reference is made to postgraduate work in radio and electronics in universities and colleges of advanced technology. Various forms of practical training are reviewed, and the report concludes with a group of general recommendations. It is advocated that there should be increased emphasis on radio and electronics in electrical engineering and in physics courses, and that there should be more new courses specifically designed to qualify for work in the radio and electronics field. There is an extensive bibliography followed by an appendix dealing with the training of technicians and craftsmen, and one compiling information about the proportion of radio and electronics work in existing courses. Two charts are given illustrating the scope of radio and electronics engineering, and the entrance requirements and basic structure of the main educational routes leading to professional, technician and craft qualifications.

The Royal College of Science and Technology, Glasgow

THE annual report on the one hundred and sixty-third session (1958–59) of the Royal College of Science and Technology, Glasgow, includes lists of titles of theses approved for the award of the degree of Ph.D., Glasgow, as well as those approved for the Postgraduate Diploma and for the Associateship of the College (Pp. 64. Glasgow: Royal College of Science and Technology, 1959). There is a further list of recent publications by members of the College, and brief reports from departments and the Glasgow School of Architecture refer to industrial reports prepared during the year by the Department of Civil, Mechanical and Chemical Engineering for the British Shipbuilding Research Association on natural circulation and heat transfer in water-tube boilers, and on the corrosion of water-cooled pistons, for the Cold Rolled Sections Association on the gusset plate strength of two-member in-line welded joints, and the collapse strength of uniformly compressed plates, and for the Motherwell Bridge and Engineering Co., Ltd., on a load-test of the Goliath crane at Hunstanton Nuclear Power Station.

Cancer of the Lung

THE report has been issued of a study-group of experts from seven countries which met in Geneva during November 1959, to review existing knowledge of the ætiology of cancer of the lung and to suggest ways of improving it (Technical Report Series, No. 192: Epidemiology of Cancer of the Lung—Report of a Study Group. Pp. 13. Geneva: World Health Organization, 1960. 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollar). The role of cigarette smoking in the causation of cancer of the lung, and of other factors such as air pollution, specific industrial causes, ionizing radiations, chronic pulmonary disease, and heredity were discussed. The study-group outlined a series of special studies designed to provide epidemiological information that will help explain the great increase in the incidence of cancer of the lung in some countries and furnish a basis for its control. They include studies of the reasons for geographical differences in the incidence of, and in mortality from, cancer of the lung; of its relative incidence in areas where the special histological classification suggested by Prof. L. Kreyberg, of Oslo, can be used; and of morbidity in countries where reliable statistics are not available. The study-group also made suggestions about the identification and intensive investigation of groups of people either exposed to an excessive degree or scarcely exposed at all to specific factors thought to have an influence on the disease, about the simultaneous study of multiple factors, and about genetic and experimental studies.

Collected Papers of the Rowett Research Institute

As in recent years, the "Summary" and "Subject Reviews", which are part of the annual volume, "The Collected Papers of the Rowett Research Institute", have been published separately and can be obtained from the Librarian, Reid Library, The Rowett Research Institute, Bucksburn, Aberdeen (5*s.*, post paid). This booklet gives a most useful and readable survey of the work of the Institute as embodied in the papers published during the academic year 1958–59. Some of the problems tackled and the results obtained are of practical importance to the agricultural industry, but many others bear on basic scientific issues, and so this summary should be of great use to a wide variety of scientists and agriculturists. Full references to all the papers published in the period are given. Many readers will find their appetites whetted for further information, and will be glad to learn that a limited number of reprints of the various papers are available for free distribution and particular ones may be obtained on application. The commendable practice has been continued of publishing two reviews on special topics in which work has been going on in the Institute for a number of years. On this occasion, the reviews are by Dr. G. A. Garton, on "Lipid Research at the Rowett Institute, 1951–59", and by Dr. G. A. Lodge, on "Experiments on the Nutrition of Sows". Both these reviews are

worthy successors to those published in earlier volumes of the "Collected Papers".

Scientific Research into Road Safety

Under the auspices of the European Productivity Agency of the Organization for European Economic Co-operation, an international meeting to discuss arrangements for co-operation in scientific research into road safety will be held at the Road Research Laboratory, Langley Hall, Langley, Bucks, during July 12–15 inclusive. Sir William Glanville, director of road research, will preside. The provisional agenda includes discussion of the progress of, as well as the responsibility for, road-safety research in various countries, possible new researches, and the best means of making known the results of research, especially to other research workers, on an international basis. Delegates will be asked to consider whether any new arrangements for closer collaboration are necessary. Delegates are expected to attend from Austria, Belgium, Denmark, France, Greece, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States; the United Kingdom delegation will include two representatives of the Medical Research Council.

The Advisory Group for Aeronautical Research and Development

The Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization announces the following schedule of meetings for the second half of 1960: August 24–26, Combustion and Propulsion Panel on "Advanced Propulsion Techniques" (Pasadena); September 8–12, a seminar jointly sponsored by the Group and the Istituto Lombardo di Scienze e Lettere, "Propulsion for Astronautics" (Varenna); September 26–October 1, Structures and Materials Panel, "Structures and Materials" (Athens); October 3–4, Fluid Dynamics Panel, "Industrial Uses of Wind Tunnels" (Istanbul); October 3–4, Flight Mechanics Panel, "Manned Ballistics and Weapons Systems Testing" (Istanbul); October 3–8, Aerospace Medical Panel, "Clinical Problems in Aviation Medicine" and "Space Flight Problems" (Istanbul); October 3–8, Avionics Panel, "Navigation" (Istanbul). The tenth general assembly of the Advisory Group for Aeronautical Research and Development will take place in Istanbul during October 6–7. Further information can be obtained from AGARD–NATO, 64 rue de Varenne, Paris VII°.

Caroline Haslett Travel Awards for Women Engineers

The General Section of the Caroline Haslett Memorial Trust has awarded travelling exhibitions to two British women engineers to enable them to study the training, employment and prospects of women engineers in the U.S.S.R. The awards, the first to be made by the General Section of the Trust, have been made to Miss L. S. Souter, who at present is head of the Magnetic Materials Section of the A.E.I. Research Laboratory at Harlow, and Miss R. Winslade, who is senior sales engineer with Research and Control Instruments, Ltd.

The Electronic Engineering Association: Awards

Under joint organization by the Radio Industry Council (London) and the Electronic Engineering Association, the scheme for awarding annual premiums for articles on electronics now reaches its tenth year. Articles published during 1960 will be considered by the panel of judges early in the New Year, and six premiums of 25 guineas will be awarded. Further information can be obtained from the Electronic Engineering Association, 11 Green Street, London, W.1, to which also eligible articles should be submitted before the end of the year.

U.S. Record of Published Books

A new *American Book Publishing Record* is now being issued which collects all entries listed in the *Publishers' Weekly* during the previous calendar month and arranged according to the Dewey Decimal Classification; a combined author and title index is included (Vol. 1, No. 2, for the month ending March 1, 1960. Pp. 96. Subscription: 11 dollars for 12 monthly issues (U.S.A. 10 dollars). New York: R. R. Bowker Company, 1960). Books are defined as non-periodical publications of 49 pages or more, and books on all subjects are included as well as those printed abroad, but 'published' in the United States in the sense of being offered for sale there through a single designated agent.

Bibliography of British Journals and Newspapers

Mr. F. Atkinson, of the Hampstead Public Library, has prepared an admirable bibliography covering, as Mr. F. Williams points out in an introduction, every book of substance dealing with English newspapers and journalism during the most expansive period in their history (Library Association. Special Subject List No. 32: The English Newspaper since 1900. Pp. 31. London: Library Association, 1960). Nearly 400 entries are classified under a dozen headings, of which biography includes most (109), and no aspect of the Press is left uncovered.

Cytology and Cell Culture Genetics of Man

"A Symposium on Cytology and Cell Culture Genetics of Man" has been published by the *Amer. J. Human Genetics* with the aid of funds from the National Institutes of Health, Public Health Service, U.S. Department of Health, Education and Welfare. Reprints may be obtained on request from Dr. Gordon Allen, Building 10, Room 2*N*208, National Institutes of Health, Bethesda 14, Maryland. The symposium is 42 pages in length and contains the following papers, originally presented in Pennsylvania on September 2, 1959: "The Chromosome Complements of Human Somatic Cells", by E. H. Y. Chu; "Human Cytogenetics: Its Present Place and Future Possibilities", by C. E. Ford; "Sexual Dimorphism in Interphase Nuclei", by M. L. Barr; "Some Systems for the Genetic Analysis of Mammalian Cells", by L. Sachs and M. Krim; and "Cell Cultures for Human Genetic Studies", by M. Fraccaro.

Royal Commission Awards for the Exhibition of 1851

The following awards for 1960 have been announced. *Senior Studentships:* B. Brummer (Imperial College of Science and Technology), for research in physical chemistry at the Imperial College of Science and Technology; M. J. M. Leask (University of Oxford), for research in physics at Oxford; S. K. Malhotra (University of Oxford), for research in zoology at Oxford; D. J. Williams (University of Sheffield), for research in theoretical chemistry at Oxford. The Senior Studentships are of the value of

£800–£900 a year and tenable ordinarily for two years. *Overseas Scholarships:* M. H. Jericho (Dalhousie University), for research in physics at Cambridge; P. S. Simony (McMaster University), for research in geology at the Imperial College of Science and Technology; A. G. Moritz (University of Adelaide), for research in physical organic chemistry at Cambridge; D. St. C. Black (University of Sydney), for research in organic chemistry at Cambridge; G. D. Jones (University of Canterbury, New Zealand), for research in physics at Oxford; P. J. Herley (Rhodes University, Grahamstown), for research in physics at Cambridge; T. J. B. Webb (Trinity College, Dublin), for research in biochemistry at Cambridge; A. J. Walton (Trinity College, Dublin), for research in physics at Cambridge; P. S. Sarin (Delhi), for research in organic chemistry at Cambridge; A. Q. Sarker (Rajshahi), for research in theoretical physics at Birmingham. The Overseas Scholarships are of the value of £550–£650 a year and tenable for two or three years.

University News:

Belfast

Dr. D. W. R. Mackenzie has been appointed to a lectureship in microbiology.

Birmingham

Dr. Stanley Mandelstam, at present assistant research physicist in the Department of Physics of the University of California, has been appointed to the newly established chair of mathematical physics within the Department of Mathematical Physics from October 1. Appointments to lectureships and research fellowships are as follows. *Lectureships:* Dr. R. W. Whitworth and Dr. A. B. Robbins (physics); Dr. J. R. Majer (chemistry); Dr. F. W. J. Teale and Dr. D. G. Walker (biochemistry); Dr. E. H. Creaser (microbiology); Dr. D. F. Gibbons (physical metallurgy). *Research fellowships:* A. H. M. Hoare (pure mathematics); J. S. Lilley (physics); B. Cockayne (physical metallurgy); E. N. Corlett (senior research fellow in the Department of Engineering Production).

Cardiff

Dr. S. P. Hutton, at present deputy director of the National Engineering Laboratory, East Kilbride, Glasgow, has been appointed professor of mechanical engineering.

Liverpool

The following appointments are announced. *Readerships:* R. L. Plackett (mathematical statistics); A. C. Shuttleworth (veterinary surgery); Dr. C. L. Smith (zoology). *Senior lectureships:* Dr. A. S. Aldred (electric power engineering); Dr. A. Bolton (civil engineering); Dr. H. W. Douglas and Dr. T. B. Grimley (inorganic and physical chemistry); Dr. V. H. Heywood (botany); Dr. J. F. Norbury (fluid mechanics); Dr. T. G. Richards (physiology); Dr. I. C. Geddes (anæsthesia); Dr. J. S. Scott (obstetrics and gynæcology).

London

The following appointments to readerships are announced: Dr. P. G. Saffman (mathematics, tenable at King's College); Dr. D. V. Ager (geology, tenable at the Imperial College of Science and Technology); Dr. M. Shepherd (psychiatry, tenable at the Institute of Psychiatry).

Oxford

Appointments to lectureships are as follows: D. F. W. Baden-Powell (prehistoric archæology); Dr. M. J. Kearsley (mathematics); Dr. H. R. Harré (philosophy of science).

Swansea

The following appointments to lectureships have been made for the session 1960–61: Mr. I. G. Evans (pure mathematics); Dr. H. T. Miles (physics); Dr. J. A. Schofield (organic chemistry). Dr. S. K. Zaremba has been appointed senior lecturer in pure mathematics.

Announcements

It has been announced that Prof. Adolf Butenandt (Munich), president of the Max-Planck Society, has been elected an honorary member of the Leopoldina German Academy of Science.

Dr. P. C. Spensley, a temporary assistant director of the Tropical Products Institute, has been appointed acting director of the Institute, until Mr. E. S. Hiscocks takes up duty towards the end of the year.

The Science Museum, South Kensington, has recently brought into operation a star-projector to demonstrate the daily motion of the stars and their appearance at different parts of the world and at different times of the year. The stars are projected on the inside surface of a hemispherical plaster dome 20 ft. in diameter. Demonstrations are given once daily, from Monday to Friday only.

The ninety-seventh meeting of the British Pharmaceutical Conference will be held in Newcastle during September 5–9. Further information can be obtained from W. K. Fitch, British Pharmaceutical Conference, 17 Bloomsbury Square, London, W.C.1.

The tenth Canadian High Polymer Forum will be held at the Alpine Inn, Ste. Marguerite, Quebec, during September 7–9. The Forum is sponsored by the National Research Council of Canada in co-operation with the Chemical Institute of Canada. Further information can be obtained from Dr. D. A. I. Goring, Canadian High Polymer Forum, Pulp and Paper Research Institute, McGill University, Montreal, Quebec.

The first International Symposium on "Cori's Ester and Phosphorylated Glucides" will be held during September 16–18 at the Museum of Science and Technology, Milan. Further information can be obtained from the Comitato Organizzatore del 1° Symposium Internazionale sull'estere di Cori e sui glucidi fosforilati, Via Modica 6, Milano.

The Department of Scientific and Industrial Research is organizing a conference on "Ergonomics in Industry" during September 27–29 at the Connaught Rooms, Great Queen Street, London, W.C.2. Further information can be obtained from Miss H. M. Clay, Department of Scientific and Industrial Research, 14–18 Cornwall Terrace, Regent's Park, London, N.W.1.

Erratum. It is regretted that an announcement referring to the seventeenth International Congress of Pure and Applied Chemistry to be held in Munich during August 26–29 was inadvertently inserted in the July 2 issue of *Nature*. The announcement is incorrect.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

RETURNS FOR 1959

THE report of the Council for Scientific and Industrial Research for the year 1959, the general theme of which is discussed elsewhere in this issue (p. 89), records gross expenditure of £10,059,376, compared with £9,453,652 in 1958, and reduced to £8,894,820 by various receipts from industry and other sources for services rendered, of which £405,514 was from other Government departments and £625,708 from industry, £483,468 in all being received by the National Physical Laboratory: the net increase on 1958 was only £536,907. Grants to students amounted to £659,818, the number of research students in training being 2,144, of whom 928 (including eighteen NATO awards) were new; advanced course studentships numbered 271, and of these 251 were new, as were 39 of the 49 research fellowships, including 22 NATO awards.

Of the research students, 254 were in biology and biochemistry, 152 in chemical engineering and metallurgy, 753 in chemistry, 62 in electrical and 138 in other engineering, 134 in geology, 30 in the human sciences, 190 in mathematics and 431 in physics. The advanced course studentships were fairly evenly distributed by subject, with 45 in physics, 44 in engineering, 37 in mathematics and 35 each in geology and in chemical engineering and metallurgy; physics (14), biology and biochemistry (13) and chemistry (11) claimed most of the research fellowships.

Grants for special researches totalled 390, of which 247 were new, amounting to £3,542,861 in the year ended March 31, 1959, and of these 63 were in biology, 77 in chemistry, 28 in geology and geophysics, 4 in mathematics, 16 in astronomy, 35 in low-temperature work and investigations on the solid state, 20 in physics, 69 (totalling £1,723,288) in nuclear physics, 59 in technology and 19 in the human sciences. Of the individual grants, much the largest is that of £400,000 to the late Prof. H. W. B. Skinner for three years from August 1, 1959, for research at the University of Liverpool in low-energy physics; other grants included £76,060 to Prof. A. B. Pippard for 3–5 years from May 1, 1960, for a magnetic laboratory in the University of Cambridge for the study of metals; £97,000 to Prof. C. C. Butler, at the Imperial College of Science and Technology, London, for 2 years from October 1, 1959, for equipment for the analysis of bubble-chamber films; £75,000 to Prof. R. Hanbury-Brown at the University of Manchester for 2¼ years from January 1, 1960, for a new type of photoelectric stellar interferometer, and £60,820 over 3 years from April 1, 1960, to Prof. A. C. B. Lovell for research with the 250-ft. steerable radio telescope and another £52,000 over 4 years for its maintenance.

With the exception of fire research, expenditure on which decreased to £29,743 from £37,174 in 1958, hydraulics research (£90,768; £100,650 in 1958), water pollution research (£100,586 from £103,882) and, surprisingly, road research, which decreased by £25,751 to £535,062 (compared with £441,762 in 1957) although work on traffic safety problems has notably expanded, the net expenditure on all branches of the Department's work increased in 1959, though that on food investigation (£326,908), forest products (£139,965), Geological Survey and Museum (£338,404) and pest infestation (£95,642) was practically unchanged. The biggest increases were in headquarters administration, etc. (£436,190 from £377,905); National Physical Laboratory (£801,550 from £737,950); National Engineering Research Laboratory, £606,055 compared with £507,104 in mechanical engineering research in 1958. Expenditure on radio research was £193,681 compared with £159,398 in 1958, and, on the new Warren Spring Laboratory, which appears for the first time in the summary of expenditure, £397,413.

Annual grants to research associations amounted to £1,683,195 (£1,700,330 in 1958) and special grants to £88,570; contributions to European nuclear research remained at £1,100,000 and expenditure on headquarters overseas liaison increased from £85,583 to £92,137.

The report records an increase in staff of the Department to 5,506; but although net recruitment over the year was satisfactory, difficulties in recruiting certain categories of staff continued. The number of research associations has now reached fifty, and at the request of the Board of Trade and the Federation of British Industries, the service of technical digests has been restarted. The Overseas Liaison Division was merged with the Headquarters Information Division at the end of the year.

THE ROYAL COLLEGE OF SURGEONS OF ENGLAND

NEW LABORATORY BUILDING

IN order to understand the importance to the Royal College of Surgeons of the laboratory block which was formally opened at the end of March, brief reference must be made to the programme of rebuilding which was started in 1952 and may be completed in 1962.

Rebuilding started in the south-eastern portion of the site, where the greater part of the Hunterian Museum formerly stood, and the first phase consisted of the Great Hall, with three floors of museums above it. The second phase is the Nuffield College of Surgical Sciences, a residence for eighty postgraduate students, which faces Lincoln's Inn Fields immediately to the east of the old College buildings and to the north of the new phase I block.

The buildings recently opened lie behind the old College and are the westward continuation of phase I, the floor-levels corresponding exactly except that there is a fifth story in the new block, which accommodates the animal house. In general terms, it may be

said that phase I is primarily a museum block, whereas the new building (phase III*a*) contains research laboratories and lecture and demonstration rooms.

The fourth floor is occupied by the Department of Anatomy, with a fine Dissecting Room at the western end and a Prosector's Room leading from it, in which anatomical teaching material is prepared. Running east from the Dissecting Room there is a corridor flanked by staff offices and research rooms where work is being done on the anatomy of conjoined twins, the nerve endings in the larynx, and in preparing material for electron microscopy. Research in this field is concerned with the structure of the nuclear cytoplasmic interface in normal and neoplastic cells; the electron microscopy of human gastric mucous membrane in relation to exfoliative cytology; and the electron microscopic changes produced in the prostatic epithelium of mice by hormonal stimulation.

At the western end of each story there is a large room, the size of the Dissecting Room, that on the third floor being used by the Departments of Physiology and Pharmacology as a demonstration room, with benches for experimental work. The research rooms on this floor belong to the Department of Ophthalmology, in which work is being done on the clinical applications of antibiotics in ophthalmology, with special reference at the moment to the possible exploitation of interferon in virus diseases of the eye; on the distribution and nature of refractive errors, especially on the optical components during growth; and on blindness, including both statistical and experimental studies. It has been established that the general pattern of retinal metabolism conforms to that of the brain, and work is being planned to seek for possible biochemical defects in the retina of rats and mice affected with hereditary degeneration of the retina.

It has been shown that sodium iodate, sodium fluoride, and a group of phenoxyalkanes can produce degeneration of the retina in the rabbit. Cysteine has been found to be effective in preventing the experimental degeneration induced by iodate and by iodoacetate, but is apparently ineffective against the phenoxyalkanes and fluoride. Work is proceeding to seek for other protective substances against both the experimentally induced lesion and spontaneously occurring blindness.

On the second floor of phase I is the main Museum of Pathology and some research rooms for the professor and his lecturers. This Department has now been able to extend into the new building, having a demonstration room at the west end and more laboratories in which at present work is being done on tissue culture and X-ray microscopy. The tissue culture work is designed to study the distribution of adenoviruses in the tonsils of normal persons in relation to age, and the incidence of virus infections of the lung. Organ culture is being carried out to assist the research already going on in the Department into lung cancer.

X-ray microscopy is being used to explore the possibilities of the method for elucidating the structure and constitution of cells and connective tissue, and to confirm by physical means some of the results obtained by histochemical techniques.

The first floor houses the Department of Dental Science, having the Odontological Museum at its western end. The research work of the Department is directed towards exploring the ætiology of pyorrhœa and dental caries. A morphological peculiarity of the interdental septum has been demonstrated whereby a trivial aberration of tooth eruption is liable to initiate a chronic ulcer between the teeth which progresses in some cases to the establishment of a pyorrhœa pocket.

On the biochemical side, research is proceeding into the amino-acid composition of enamel protein, and it has been shown that this protein is quite different from other skin keratins; and on the bacteriological side, a special study is being made of the organisms capable of living on enamel proteins.

A third problem engaging the attention of the Department is the determination of the earliest reaction of bone to metastatic deposits of carcinoma; and a study is also being made of salivary gland metabolism using radioactive tracers.

On the ground floor there are two committee rooms, a Fellows' Common Room, and an excellent lecture theatre to seat 140 students, a great asset to the College, which is, however, still short of lecture and demonstration room-space to meet all the requirements of its educational programme. The building of phase III*b*, which will complete the restoration of the College, is planned to make good these deficiencies.

THE ROYAL BOTANIC GARDENS, KEW

THE Students Day at the Royal Botanic Gardens, Kew, was held this year on May 7. Many universities, schools and training colleges were represented as well as members of a number of scientific societies. Altogether, about six hundred visitors were present. The exhibits this year were not restricted to the Herbarium but were spread over the various buildings and greenhouses at the north end of the Gardens.

Many of the Herbarium exhibits were concerned with the work of the taxonomist. Starting with the collection of plants in the field, there were demonstrations of drying and mounting leading to the ultimate naming and classification of the specimens. The work of the monographer was also demonstrated, with particular reference to the genus *Ficus* (figs), which includes nine hundred species.

A challenge to visitors was provided by an exhibit illustrating the classification of grasses. Two contrasting sets of specimens were displayed. In one, seven of the larger tribes were illustrated by herbarium specimens which were typical in respect of their inflorescences and spikelets. Contrasted with these were a number of non-typical examples from the same tribes, in which there were certain mutual resemblances. The compact spike-like inflorescence illustrated by *Chaetostichum minimum* in the Chlorideae, *Rhytachne rottboelloides* in the Andropogoneae and *Prionathum pholiuroides* in the Danthoneae were surprisingly similar. This apparent parallelism, however, was shown to be misleading, since diagnostic characters other than those of gross morphology are essential to the correct placing of a given species. The employment of other criteria such as the nature of

epidermal hairs, leaf anatomy, type of starch grains and basic chromosome numbers has led, in some instances, to a change in tribal position. Exhibits relating to the many Floras now being prepared at Kew were also on view in the Herbarium, while in the Library an interesting selection of botanical books and periodicals were laid out on the tables.

Many of the exhibits displayed by the curator and his assistants were primarily of horticultural interest although not lacking in scientific appeal to the student of botany. For example, the exhibit of a large number of species of *Saxifraga* illustrating the astonishing diversity in habit, form and geographical distribution could scarcely have failed to impress the teacher as well as the student.

Another garden exhibit, illustrating methods of climbing in plants, showed a series of living examples, other than text-book subjects, although some of the more popular species were also displayed. *Semele androgyna*, for example, is known to most students as an example of cladode development, although few would have guessed it was a climbing plant capable of attaining a height of 35 ft. The exhibit staged by the Arboretum Department concerning seed storage was devoted to the problem of maintaining viability of certain seeds of deciduous trees and shrubs. Under natural conditions the seed is shed into a moist leafy medium, where it normally remains until germination. With seeds which are collected and stored, the requisite conditions of moisture and aeration can be simulated by placing the collected seeds—acorns, for example—in polythene bags together with damp peat and maintaining them at a temperature of 36° F. Viability can then be assured for several months. The problems involved in the germination of hard-coated seeds were also dealt with. The seeds of holly, *Pyracantha* and others with stony endocarps are subjected to 'stratification'. The seeds when gathered are placed in boxes of damp sand in successive layers and placed in the open. Here they are exposed to the elements for maybe a year or more, after which time the endocarps have become sufficiently softened to permit germination. Another method of accelerating germination depended on the principle of vernalization. A sample of *Malus* seed had been maintained at a temperature of 36° F. for sixty days and then subjected to two 1-sec. dips at 10-min. intervals in water at 165° F. The seeds then showed radicle development at an advanced stage and a batch of seed so treated had actually germinated within a few days.

An impressive exhibit displaying methods of vegetative propagation demonstrated the use of various growth-promoting substances in the quick establishment of cuttings. The formation of callus in treated and untreated examples was illustrated, and the methods used in propagation by leaf, root and stem cuttings were also demonstrated. A working mist-unit which automatically maintains a constant humidity in a propagating house was also on view.

The exhibit in the Ferneries was notable for a fine display of young sporophytes of the rare monotypic *Regnellidium diphyllum*, a member of the Marsiliaceae; few students could ever have seen living specimens of this interesting South American genus. In addition, there were examples of the early stages in the development of the fern sporophyte and an interesting demonstration of the vegetative propagation of species of *Selaginella* and *Lycopodium*. These genera, which are difficult or impracticable to raise from spores, are in most cases readily raised from leaf or stem cuttings.

In the Jodrell Laboratory a number of exhibits were displayed to illustrate the multifarious activities of its staff. Besides demonstrations of the methods used in preparing materials for microscopical examination, several examples were shown of commercial vegetable products which had either been adulterated with worthless material or were completely spurious.

Finally, mention should be made of the exhibit shown in the Herbarium, prepared and loaned by the British Council, consisting of forty-four panels illustrating the history and activities of the Royal Botanic Gardens, Kew. Intended primarily for displaying overseas, they were quite excellent in presentation and were universally admired.

F. Ballard

INFLUENCE OF EDITORS

THE question of how far an editor should go in correcting an author's manuscript was discussed on April 29 at a meeting of the Scientific Publications Council. Dr. G. E. W. Wolstenholme (Ciba Foundation) was in the chair.

Dr. R. D. Keynes (Cambridge) said an editor has a dual responsibility (*a*) to the author and (*b*) to the reader. Many authors submit manuscripts containing a long historical introduction and a discussion that is a wearisome repetition of the results. Sometimes the statistical evidence is inadequate, means are calculated incorrectly and the author gives figures that do not support what he says. However, conformity to a standard form of presentation should not be insisted on too rigidly, and in matters of taste the author should always have the last word. But an editor should insist on clarity; and he must be fierce in ensuring the accuracy of any data that are published. Some editors send the author a report from an anonymous referee, but anonymity is apt to cause resentment; an editor writing personally can often be much ruder and more effective without causing ill-feeling. As a university teacher, Dr. Keynes was concerned at the number of text-books and symposium volumes that bear the names of eminent scientists as editors, but in which the so-called editors have not really done any editing at all. The frequent contradictions in the different chapters are troublesome to student and teacher alike. Editorial interference may be objectionable, but editorial neglect is worse.

Dr. A. S. Parkes (National Institute for Medical Research) agreed that an editor had many responsibilities; but in the long run the author bears the full responsibility for every paper bearing his name. In particular, an editor should not rely too much on a referee, who may well have his own axe to grind, and who, being anonymous, has no right to try to insist on major alterations to someone else's paper. He recognized fully, from his own experience, that young authors can benefit enormously from the constructive criticism of more experienced writers: but

papers should go through the moulding stage before they are sent for publication. The head of a department should see that all papers leaving it are in good shape and worthy to bear its name.

Prof. E. J. King (British Postgraduate Medical School) said that manuscripts written by scientists are often very poor, and heads of department cannot be expected to replace the experienced editor in the highly skilled task of revising for publication. Editing is a burdensome job, and most scientists are grateful to the editors who give their time to it. Editors should do as much rewriting as they think necessary. But an editor needs to be a diplomat: he must know how to effect a useful compromise without causing resentment.

Mr. A. L. Bacharach (*J. Nutrition*) said that the basic question is: How much should an editor do? Some scientists are glad to have their manuscripts revised, but others go so far as to assert that papers should appear just as they are written, even complete with grammatical errors. The purpose of publication is to spread new information, and a paper will do this only if the reader has confidence in the author. Grammatical errors, verbosity and repetition undermine the confidence of the reader and should be corrected. It is helpful if manuscripts go through a process of 'internal editing' within a department (not necessarily by the head) before they are sent for publication. In one department that had adopted this procedure for more than fifteen years, only one in some two hundred of the papers sent for publication had been rejected or returned for rewriting. An editor is entitled to make every alteration he thinks necessary to improve the clarity and intelligibility of a paper, so that it can be read with intellectual comfort. Those who resist such alterations are generally the bad scientists—the good ones are glad to have their papers improved.

Dr. R. K. Callow (National Institute for Medical Research) said that a part of the problem is that some scientists are completely blind to typographical, grammatical and logical errors and unable to understand the concern that others feel about them. In his experience, a journal in which an editorial board of scientists did most of the editing, and a staff editor did only sub-editing, achieved the happiest author–editor relationship. It was less satisfactory to have a system of refereeing in which the expression of opinion was limited ('suitable' or 'not suitable' for acceptance) and papers were altered by a staff editor to fit them into a stereotyped scheme for the concise recording of data.

Dr. I. Bush (Oxford) complained of over-zealous editors and laggard referees who hold up publications while making numerous changes, which are not of the first importance, in the manuscripts. Editorial requirements are so numerous and various these days that many otherwise conscientious authors do not take the maximum trouble in preparing their manuscripts since experience leads them to believe that, whatever they do, the editors will always raise a large number of objections or alternatives. He pointed out that Dr. Detlev Bronk had recommended a decrease in 'editorializing' in an article some years ago.

Dr. T. H. Osgood (U.S. Embassy) said that in his American experience, the insensitivity of some authors to shades of meaning lent credibility to the story told by a fellow editor that occasionally his letters of rejection took the form: "Dear Sir, Although your paper fills a much-needed gap in the literature, I regret that it cannot be accepted for publication". It was unfortunate that editors were, on occasion, forced to undertake the education of authors, but when it became known that the correction of errors and the questioning of editorial judgment involved considerable delay, authors took exceptional pains to present good manuscripts. In view of the normal anxiety of an author to see his paper in print, the threat of delay was the best weapon for ensuring the effectiveness of editorial influence. An editor who did his job well must expect to make one or two enemies every year.

Mr. F. Clark (*Biochemical J.*) described the work of a professional editor, whose services may be required for large scientific journals where much of the editorial work formerly done by the chairman and other members of the editorial board can be transferred to the editorial office.

Dr. G. E. W. Wolstenholme (Ciba Foundation) said it is difficult for scientists from abroad to understand the requirements of journals in another country. Some scientists whose papers are rejected are convinced that the editors have a personal grudge against them.

This short meeting had shown how helpful it could be for authors and editors to get to know each other: in that way many mutual difficulties could be ironed out.

D. RICHTER

THE BRITISH RAYON RESEARCH ASSOCIATION

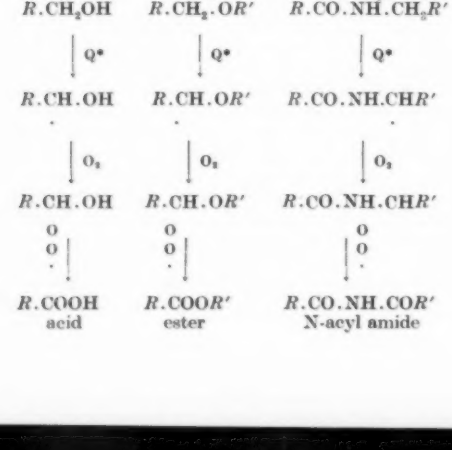
THE annual open days of the British Rayon Research Association's Heald Green Laboratories at Wythenshawe were held during May 11–13. The total attendance was 900. Last year the work on 'fluid beds' and on vibration problems on spinning machinery was not demonstrated, but, because of the progress made, it was possible to give impressive demonstrations of both these aspects this year.

In the 'fluid beds', on which the Association has been working for the past few years, the bed material is small glass beads (dimensions 1 mm.–0·25 mm.) and the fluidizing agent is air. The particular virtues of fluid beds are: (*a*) that high rates of heat transfer can be achieved between a heat source in the bed and the material to be heated, for example, fabric or cord; (*b*) that the bed can be operated at high temperatures; and (*c*) that the temperature is uniform across the bed. Fabric or cord can either be introduced at the bottom and removed from the top of the bed (single-pass bed) or both entry and removal can be at the top (double-pass bed), in which case it is passed round an internal roller or similar device at the bottom. The problem is to achieve this with low cloth tensions. The current position is that fabrics can be passed through single-pass beds under a tension

of 2–4 lb. per yard width per 6-ft. path-length in the bed and under a tension of 4–6 lb. for the same conditions in a double-pass bed. Much effort has gone into this development, and these tensions are sufficiently low for satisfactory treatment of cloth. Detailed measurements of heat transfer and rate of removal of water from cloth (drying) have been made as a function of bed temperature and rate of input of air per unit area of bed. There are therefore sufficient data available for a proper analysis of its possible use as a drying machine. For a number of practical reasons the most promising applications are the dyeing of hydrophobic fibres, such as nylon, 'Terylene', etc., and the heat treatment of tyre-cords of nylon or other thermoplastic materials. These two aspects have received the most attention during the past year, and demonstrations of the application of this technique to ribbon-dyeing and to the heat-setting of nylon tyre-cords were given.

The problem of how to give fabrics of continuous filament viscose rayon the same visual degree of crease-shedding as can be obtained on fabrics of spun-yarns has not been solved. The problem is more difficult to solve with these fabrics because, as their surface is so uniform, the eye can detect creases which would not be noticed in spun-fabrics; for example, to produce a visually acceptable fabric a higher degree of crease-recovery is necessary with these fabrics than with spun-fabrics. A systematic exploration of the effect of varying the parameters, for example, chemical nature of treatment, temperature of treatment, drying conditions, in known techniques of achieving crease-resistance has shown that there is a good correlation between crease-recovery and loss of abrasion resistance, that is to say, although it is possible to obtain the high degree of crease-recovery necessary, the associated reduction in abrasion resistance is such as to render the fabric valueless. It can be inferred, therefore, that all the treatments so far investigated which appear to increase the 'yield point' of the fibres, that is, the region of elastic deformation, simultaneously lead to a reduction in the breaking strain.

Two features of nylon have been investigated. The first one is the photo- and thermo-chemical degradation of nylon. This problem has been approached by studying the photo-sensitized oxidation of simple compounds, the N-alkyl amides, which should show the same chemical behaviour, in principle, as polyamides. With photo-chemical sensitizers, for example peroxides, it has been shown that the main reaction product is that which would be expected by analogy with previous work on alcohols and ethers:



It has been conclusively shown that N-acyl amides are the primary product for a large range of N-primary alkyl amides. An initial study of the thermal oxidation, over the temperature-range 110–180° C., has shown that the major products from N-ethyl and N-propyl propionamide are again N-acyl amides, that is to say, thermal oxidation would appear to involve a specific hydrogen abstraction, namely from the carbon α to nitrogen, either in the initiation or propagation stage.

The second feature of nylon which has been studied is the structure of spherulites grown from the melt. Narrow-beam X-ray techniques have been used to study orientation, and it has been shown that the *a* axis of the unit cell lies along the radius in positively birefringent spherulites. The zig-zag extinction pattern shown in the polarizing microscope by some of these spherulites can be understood in terms of this orientation and a structure in which successive crystalline units along a radius show a progressive rotation (twist) around this radius with an optically resolvable pitch. The orientations in negatively birefringent spherulites and in spherulitic aggregates have also been studied. Further work is being carried out by electron microscopy in order to characterize the geometrical nature of the crystalline units from which the spherulites are formed.

An essential stage in the production of textile fibres is drawing, which brings about molecular orientation and an anisotropy in physical properties. Apart from previous work on cellulose film in the Laboratories, no attempts have been made to investigate the anisotropy of the mechanical properties, although the behaviour of fibres under lateral forces may well be as relevant to obtaining an understanding of the physical properties of yarns and fabrics as the axial tensile properties which are usually measured. Using polythene film (see *Nature*, **184**, 600; 1959), measurements of the Young's modulus of strips cut at three angles ($\theta = 0°$, 45° and 90°) to the symmetry direction (direction of drawing) have been made. With increasing draw ratio at 20° C. the moduli at 0° and 90° to the axis of symmetry first decrease and then increase very markedly. This unexpected behaviour is not explicable in terms of a reduction in order, since density and molecular orientation (by X-ray measurements) increase monotonically with increasing draw ratio. Even more unexpected is the behaviour at $\theta = 45°$. In this case the modulus decreases smoothly as the draw ratio increases. This behaviour of polythene differs markedly from that of cellulose, for which some less-extensive data are available, but it is clearly of sufficient importance to justify the investigation of other polymers in a similar way.

Apart from these investigations, aspects of much other technological work were on show. Of particular interest to the textile industry were the different types of slub-catchers for removing slubs from yarn, a demonstration of the effect of spindle eccentricity on ring spinning frames on producing hairiness in yarns, and the effect of pirn winding tensions and humidity conditions on the production of weft bars in nylon fabrics.

The number of staff of the Laboratories is 230, comprising research staff, 80; laboratory and technical assistants, 57; engineering, drawing office and maintenance staff, 52; library and administrative staff, 32; canteen staff, 9.

L. A. Wiseman

OCEANOGRAPHY OF LONG ISLAND SOUND

VOL. 17, Art. I, of the *Bulletin of the Bingham Oceanographic Collection** contains six papers on widely different aspects of the oceanography of Long Island Sound, with the emphasis on the cycle of organic production, and a guide for preparing figures written by the editor, Ynge H. Olsen, with James E. Morrow, research associate. The volume opens with an obituary notice of Eugene Harris, who had not fully completed the manuscript of his important contribution on the nitrogen cycle when he died. The senior author, Dr. Gordon A. Riley, completed it, and from the paper itself it is clear to all who wrestle with the problems presented by organic production in the sea that further contributions of high standard would have come from Harris had he lived.

The volume as a whole is a continuation of a series of seasonal studies, continued over a period of years, in the attempt to establish the various parameters, physical, chemical and biological, that seem to exert most influence on the production of plankton, and secondarily on the higher forms of life such as sand-eels and other fishes, in this area. Numerical values for the most important of these parameters having been established, the final approach to solution of the organic cycle is by the mathematical methods previously employed by Dr. Riley in studies of more strictly oceanic areas.

Marine biologists in Great Britain may gain a fair idea of the scope and importance of the work if it is said that it presents a close parallel to that carried out by Dr. Harvey and his co-workers of the Plymouth Laboratory in the coastal waters of the English Channel some twenty-five years ago. Long Island Sound is a more enclosed and more strictly coastal sea-area, with more extreme seasonal variation in such parameters as temperature and salinity, due partly to the climatic differences of an area on the eastern side of a continent. Moreover, the American workers began with all the advantages of the research and discussion that have accrued during the intervening years, with attendant improvements in technique; while the more-sheltered situation must have greatly assisted in the maintenance of wider and more prolonged seasonal coverage.

The general account given by Dr. Riley shows that the phytoplankton cycle is somewhat different from that observed off north-west Europe. A late-winter flowering dominated by diatoms such as *Skeletonema costatum* and *Thalassiosira nordenskiöldii* occurred, with its peak between January and March, in each of the years studied, that is, roughly one month earlier than the spring flowerings studied by European workers. Subsequent less-regular flowerings in May or June consisted predominantly of dinoflagellates. The phytoplankton of the western (enclosed) end of the Sound was so much greater than that near the open end that there the chlorophyll concentrations during post-flowering periods were as high as those representing flowerings at the eastern end. It was thought that relatively low-grazing intensity at the western end partly accounted for this great disparity. Autumnal flowerings were less regular than the others, but of very considerable magnitude. A fairly satisfying argument postulating increased stability of the surface layers as the prime factor promoting the richer antumnal outbursts is presented.

Harris's contribution established nitrogen as the most probable limiting factor among the essential nutrients in this area. As stated in Riley's general account, the relative poverty is shown by nitrogen/phosphate ratio of between 5 : 1 and 8 : 1 by atoms, between one-third and one-half the values found in the Atlantic area generally. It is pleasing to find Cooper's concept of the "anomaly of the phosphate/nitrate ratio" so useful in defining the nutrient characteristics of a region very different from most of those in which such work has been done before.

Harris showed further that ammonia was superior to nitrate and nitrite as a source of nitrogen for the phytoplankton studied in most instances, and not inferior to them in the remainder. In the discussion he developed a most interesting hypothesis to the effect that in strongly stratified surface waters, when nitrogen quantities are near minimal, but organic matter tends to a maximum near the thermocline, vertical zooplankton migrations may help to slow down depletion of the epithalassa in this respect, or even very slightly to increase the quantities available.

Riley and Schurr present a very detailed analysis of the various parameters affecting transparency of the waters as indicated by a fine series of Secchi-disk readings. Here I must confess to feeling rather unconvinced by the mathematical treatment of some of the more obviously inter-related physical factors influencing the maintenance of suspensoids in the upper layers, as wind stress, mean stability, tidal-current speed and depth. The time factor appropriate for the first two seems so uncertain that one doubts the adequacy of the statistically computed partial correlation coefficients to express these. This is not to query the correctness of the conclusions reached, where the possible effects of some of the 'unknowns' are quite fairly stated in more general terms.

A brief trenchant note by Riley on the particulate matter in the Sound shows that although the amount of detritus is exceptionally large its distribution seems to bear little direct relation to the phytoplankton cycle. From the seasonal imbalance between production and consumption it seems that some of it has a slow rate of degradation. Thus it may provide less-suitable food for the zooplankton than would seem probable from the evidence that the latter can assimilate more nitrogen than is to be found in the phytoplankton. The part played by organic detritus in a relatively shallow enclosed sea-area like the Sound, where local turbulence often churns up the bottom deposits, must be more complicated than it is in oceanic areas where it sinks out of the immediate circulation in the surface layers.

Peter J. Wangersky examined the carbohydrate content of water samples from the Sound throughout

* *Bulletin of the Bingham Oceanographic Collection*, Vol. 17, Article 1: Oceanography of Long Island Sound. By Gordon A. Riley, Eugene Harris, Henry M. Schurr, P. T. Wangersky, Sarah W. Richards and R. Wade Covill. Guide for preparing Figures. By Y. H. Olsen and James E. Morrow, Jr. Pp. 153. (New Haven, Conn.: Peabody Museum of Natural History, Yale University, 1959.) 3.50 dollars.

one year's plankton cycle. He found none present during a spring diatom bloom and significant amounts (0·5–1·5 mgm./l.) only towards the end of a July dinoflagellate bloom. These amounts were an order of magnitude less than those found in bacteria-free pure cultures of the same organism. He concludes that the material is being utilized almost as fast as it is released: the small quantities present may even be more indicative of rapid utilization than of small production. I cannot wholly agree with his concluding sentence: "Elucidation of the relationships between dinoflagellates and marine bacteria is *primarily* a task for pure culture techniques in the laboratory" [italic mine]. Doubtless the laboratory approach is likely to be more immediately rewarding in the present state of knowledge (or lack of knowledge) concerning these organisms, but if anything seems certain about them it is that it would be most unsafe to extrapolate from culture conditions to those existing in Nature without concomitant planned field-work, which should surely be regarded as a primary part of such studies.

The collections of fish eggs and larvæ made by Dr. Riley were studied by Sarah W. Richards in continuation of earlier work by Wheatland. The majority of the twenty-two species proved to be summer spawners. In winter no eggs were taken, and larvæ of only one species, *Ammodytes americanus*, occurred in abundance. Fluctuations in annual totals were caused mainly by the most abundant species, particularly the anchovy, *Anchoa mitchilli mitchilli*. Only six other species were recorded in large numbers. A greater abundance and variety of species spawned in the western part of the Sound than in the central and eastern portions throughout the year. It appeared that for summer spawners large larvæ from large eggs did not have an advantage over small larvæ from small eggs since the latter hatched at a time of greater food supply.

R. Wade Covill presents a detailed study of the stomach contents of 200 larval and post-larval sand-eels, *Ammodytes americanus*, 3·2–23·1 mm. long. Comparison with data from elsewhere showed fewer empty stomachs among the Long Island Sound material; evidently the Sound provides good feeding for the young of this species. Copepods and their nauplii were the most important food organisms, but phytoplankton was also an important food, especially for the younger and smaller larvæ. It is shown that the larvæ must ingest a considerably greater quantity of food a day than can be deduced from direct examination of stomach contents for growth to continue.

Finally, the editors offer first-class advice and instruction regarding the production of the figures with which papers of this kind should be illustrated. No marine biologist can cavil at anything they have to say, for all the advice is excellent.

Is it not a little unjust to expect marine biologists to be good draughtsmen as well as possessing the wide range of professional knowledge and other semi-specialist skills that they must strive to attain in order to do their job well? Many who are not so gifted are no wit inferior as scientists to those gifted with a natural facility for drawing. The number of research workers who can hope for the collaboration of a good illustrator is very limited, at least in Great Britain. Too much insistence upon a high standard of graphic presentation can thus lead to suppression of valuable results.

Another point which this, in itself unexceptionable, set of instructions impels one to raise is the need in marine biological papers for less size reduction of figures and more reference lines on graphs (which most editors seem to abhor). Such work often involves voluminous raw data, which for economic and other reasons are nowadays rarely published in full. Graphs from which the values really can be read off are therefore almost the last line of defence against destructive critics who make much of possible alternative arrays of the data, which on close examination are almost always found to be inferior to those selected by the individual who did the work.

T. John Hart

ARTHUR D. LITTLE RESEARCH INSTITUTE

THE annual report for 1959 of the Arthur D. Little Research Institute, which includes a list of thirty-six publications, nineteen during 1959, records a considerable increase in the scale and scope of the Institute's activities during this its third year of operation, though, as Dr. F. N. Woodward, its director, observed in a paper on sponsored research in *Chemistry and Industry* for January 9, 1960, not more than £300,000 was collectively covered by the three contract research institutes in Great Britain and the research associations of the Department of Scientific and Industrial Research for sponsored research in 1958 (pp. 39. Inveresk, Midlothian: Arthur D. Little Research Institute, 1960).

An investigation aimed at the preparation of polymers from derivatives of glucose was initiated under a four-year grant from the United States Department of Agriculture, and a study of the bulk properties of polymers is being jointly sponsored by British and American companies. A study of aluminium chemistry is being undertaken on behalf of the Atomic Energy Authority, and the chemistry and polymerization of ethylene sulphide are being investigated for a European sponsor.

The work on the chemistry of sodium sucrates continued and has opened a new route for the preparation of a wide range of sucrose derivatives of potential value, including the sucrose fatty esters, although the problem of removing 'bound' ammonia from sucrates prepared in liquid ammonia has not been completely solved. In the work on the mechanism and kinetics of the formation of isotactic polymers, a new flow apparatus was built and the continuous-flow technique adopted to overcome the difficulty of preparing a reproducible Ziegler catalyst surface, and to afford some insight into the problem of making the polymer production process continuous. An improved model of the viscodensitometer was built and calibrated.

Work in the corrosion field was particularly fruitful, and 450 organic compounds were tested for inhibitory power using the rapid methods described in the previous report. Although the results did not establish any clear-cut correlation between chemical

constitution and inhibitory power, they should assist the selection of compounds likely to be effective as inhibitors. Electrochemical methods of studying inhibition have also given interesting results, and the technique of studying inhibition in a flow apparatus with a controlled atmosphere has been considerably improved. Studies of the chemical modification of wood have been extended to include modification of blocks of sapwood specimens and of veneers with the view of assessing improved dimensional stability, and methods have been worked out for the routine evaluation of changes in the physical properties of veneer and whole-wood resulting from chemical modification, and a rapid screening technique for evaluating rot resistance properties of sawdust samples. Infra-red spectroscopy proved to be a particularly valuable method for examining comminuted wood samples.

POLYPEPTIDES OF THE HUMAN PITUITARY WITH DIRECT ACTION ON METABOLISM

By Dr. J. BORNSTEIN and DEIRDRE HYDE
Diabetic and Metabolic Unit, Alfred Hospital, Melbourne

THE observation by Baird and Bornstein[1], that residues of plasma following an acid solvent extract contained a fraction capable of inhibiting the uptake of glucose by rat diaphragm, led to the investigation of the human pituitary as a possible source of this material.

Acetone-dried pituitaries are extracted with a mixture consisting of ethanol, 4 vol.; *n*-butanol, 0·4 vol.; toluene, 0·4 vol.; and water, 1·0 vol.; hydrochloric acid to *p*H 1·5 for 5 hr. The supernatant is discarded, and the wet residue incubated for 4 hr. at 37° C. and then vacuum dried to remove all traces of solvents. The dry cake is pulverized and extracted with 0·1 *M* acetic acid. The extract is then ultrafiltered through 'Cellophane' at 40 lb. per square inch and the ultrafiltrate either freeze dried or precipitated with 15 volumes of absolute ethanol (dried over calcium oxide). The activity of this fraction (*P.U.F.*) is shown in Table 1.

The crude ultrafiltrate was added at a concentration of the equivalent of 1 gland/ml. of buffer.

The ultrafiltrate is then chromatographed on a column of 'Zeokarb 225*H*' or '*IRC* 120*H*', the column being developed with water, 0·1 *M* triethylamine acetate buffer *p*H 6, followed by 0·1 *M* triethylamine buffer *p*H 9·4. Three peaks are observed, the first fraction (HP_1) not absorbing on the column, the second (HP_2) being eluted with buffer *p*H 6 and eluting at *p*H 5·2–6·0 and the third (*BP*) at *p*H 9·4. The third peak (*BP*) has been inert in all systems and no further reference will be made to it. HP_1 and HP_2 showed opposite effects on glucose uptake by rat diaphragm, HP_1 producing acceleration and HP_2 inhibition (Table 2).

Table 1. Effect of Crude Ultrafiltrate on Glucose Uptake by Rat Diaphragm (2)

No. of preparations tested	No. of diaphragms	Glucose uptake in mgm./gm./hr.			
		Control	With *P.U.F.*	Diff.	*P*
6	36	4·54 *S.E.*	3·76 ±0·14	0·78 ±0·085	< 0·001

The inhibitory effect of fraction HP_2 has also been investigated in the following systems.

(*a*) The oxidation of U–^{14}C glucose by paired liver slices (Table 3).

(*b*) The incorporation of carbon-14 amino-acids into protein of rat diaphragm both *in vitro* and following pre-injection of animals.

The diaphragms of rats starved for 18 hr. were incubated in the presence of a protein hydrolysate of activity 1 μc./ml., total amino-acids 80 μgm./ml. and insulin 1 × 10^{-3} unit/ml. No glucose was added. In injection experiments 160 μgm. HP_2 was given subcutaneously 18 hr. before death and 160 μgm. HP_2 intravenously 30 min. before death. Protein was isolated according to the technique of Manchester and Young[4]. The results are shown in Table 4.

(*c*) Effect on the incorporation of ^{14}C-1-acetate into fatty acids and unsaponifiable lipids by liver slices both *in vitro* and following injection.

Liver slices taken from rats starved for 18 hr., paired in the case of *in vitro* experiments, and pooled in injection experiments, were incubated in the presence of ^{14}C-1-acetate 1 μc./ml., acetate concentration 300 μgm./ml., glucose concentration 2 mgm./ml. Where injection of animals was undertaken it was carried out as under *b*. The fatty acids and unsaponifiable lipids were recovered according to the technique of Hastings *et al.*[5]. The results are shown in Table 5.

The unsaponifiable lipids from this series show the same trend as in the *in vitro* studies, but the results are not statistically significant.

Table 2. Effect of Fractions HP_1 and HP_2 on Glucose Uptake by Rat Diaphragm

Peak	No. of preparations tested	No. of diaphragms	Concentration in μgm./ml.	Glucose uptake by rat diaphragm mgm./gm./hr.			
				Controls	+ HP_1	Diff.	*P*
HP_1	4	18	30 *S.E.*	4·39 ± 0·26	5·46 ± 0·29	+ 1·07 ± 0·247	< 0·01
					+ HP_2		
HP_2	9	66	160 *S.E.*	4·72 ± 0·16	3·32 ± 0·17	− 1·40 ± 0·126	0·001

[1] Baird and Bornstein, *Nature*, **182**, 1179 (1958).
[4] Manchester and Young, *Biochem. J.*, **73**, 274 (1959).
[5] Hastings *et al.*, *J. Biol. Chem.*, **214**, 647 (1955).

Table 3

No. of preparations tested	No. exps.	Concentration HP_2 in μgm./ml.	Counts/min./100 mgm. tissue recovered as $BaC^{14}O_3$			
			Controls	$+HP_2$	Diff.	P
4	11	160	476	415	−61	0·01
		S.E.	±41·4	±29·7	±14·9	

Table 4. Effect of Fraction HP_2 on Incorporation of Carbon-14 Amino-acids into Protein of Rat Diaphragm

No. of preparations tested	(1) *in vitro*					
	No. of diaphragms used	Conc. HP_2 μgm./ml.	Counts/min./mgm. protein recovered			
			Controls	$+HP_2$	Diff.	P
3	9	60	1,991	1,537	−454	0·01
		S.E.	±215·6	±143·3	±108·9	
	(2) following injection as above					
	No. of animals used		Counts/min./mgm. protein recovered			
	Controls	Injected	Controls	Injected	Diff.	P
4	15	15	2,322	1,785	−537	0·01
		S.E.	±84·6	±119·2		

All radioactive samples were counted in a Nuclear Chicago *D*47 gas-flow tube and corrected to infinite thinness. Electrophoretic study of fraction HP_2 shows that it behaves as a substantially homogeneous substance both in starch and moving boundary experiments, and preliminary study indicates a molecular weight in the vicinity of 2,500. Acid hydrolysis yields approximately 19 amino-acid residues. The material is stable to freeze drying, a temperature of 60° C. for 4 hr. in acid solution, but is rapidly destroyed at *p*H 9.

Discussion. Fraction HP_1 appears to have insulin-like activity when tested on the rat diaphragm, but has not been further studied.

Fraction HP_2, on the results obtained, seems to have a general anti-insulin action inhibiting glucose uptake by muscle, glucose oxidation by liver, protein synthesis by muscle and fatty acid synthesis by liver tissue and probably accelerates cholesterol synthesis in the liver.

Although the effects on the biochemistry of living animals are at present being studied, it cannot as yet be said whether the material is actively diabetogenic in the same sense as growth hormone in suitable animals.

Table 5

No. of preparations tested	(1) *in vitro*—fatty acids					
	No. of exps.	Conc. HP_2 μgm./ml.	Counts/min./100 mgm. liver—fatty acids			
			Controls	$+HP_2$	Diff.	P
5	16	60	589	334	−255	0·001
		S.E.	±51·6	±40·4	±30·3	
	(2) *in vitro*—unsaponifiable lipids					
			Counts/min./100 mgm. liver—unsaponifiable lipids			
6	16	60	286	394	+108	0·01
		S.E.	±33	±51	±31	
	(3) following injection—fatty acids					
	No. of animals used		Counts/min./100 mgm. liver—fatty acids			
	Controls	Injected	Controls	Injected	Diff.	P
4	15	14	529	381	−148	0·01
		S.E.	±32	±35		

The relation of this apparently polypeptide fraction to the well-known similar effects of growth hormone following the injection of that substance is at present not known, but it is possible that it represents an active fragment split from the growth hormone molecule.

Again it is not possible to state whether this fraction is the same as that described by Baird and Bornstein[1], although there is considerable similarity in the technique of preparation.

Further work as to biological activity, molecular size and structure is in progress, and full details will be published elsewhere.

This work was supported by grants from the Australian National Health and Medical Research Council, Eli Lilly and Company and the Life Officers Fund of Australia and New Zealand.

[1] Baird, C. W., and Bornstein, J., *Lancet*, 1111 (1957).
[2] Park, C. R., Brown, D. H., Cornblath, M., Daughaday, W., and Krahl, M. E., *J. Biol. Chem.*, **195**, 197 (1952).
[3] Bornstein, J., and Hartman, B., *Nature*, **176**, 788 (1955).
[4] Manchester, K. W., and Young, F. C., *Biochem. J.*, **72**, 136 (1959).
[5] Renold, A. E., Hastings, A. B., Nesbett, F. B., and Ashmore, J., *J. Biol. Chem.*, **213**, 135 (1954).

IMMUNO-ELECTROPHORETIC DIFFERENTIATION OF HAPTOGLOBINS FROM ANOTHER GROUP-SPECIFIC INHERITABLE SYSTEM IN NORMAL HUMAN SERA

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With the aid of immuno-electrophoresis[1,2] at least twenty-five precipitating components can be characterized in a single normal human serum by means of a slightly modified technique, which seems to give a better resolution of the components[3,4].

In Fig. 1, a schematic drawing of these components from magnified photographs is given; precipitates which are still unidentified are denoted as α_1-globulin I, II, etc., according to their electrophoretic positions in immuno-electrophoresis under the conditions employed.

At least two evidently independent group-specific systems have also been observed, whereby normal human sera can be divided into three groups depending on variations in electrophoretic position of the haptoglobin precipitates, as well as three further

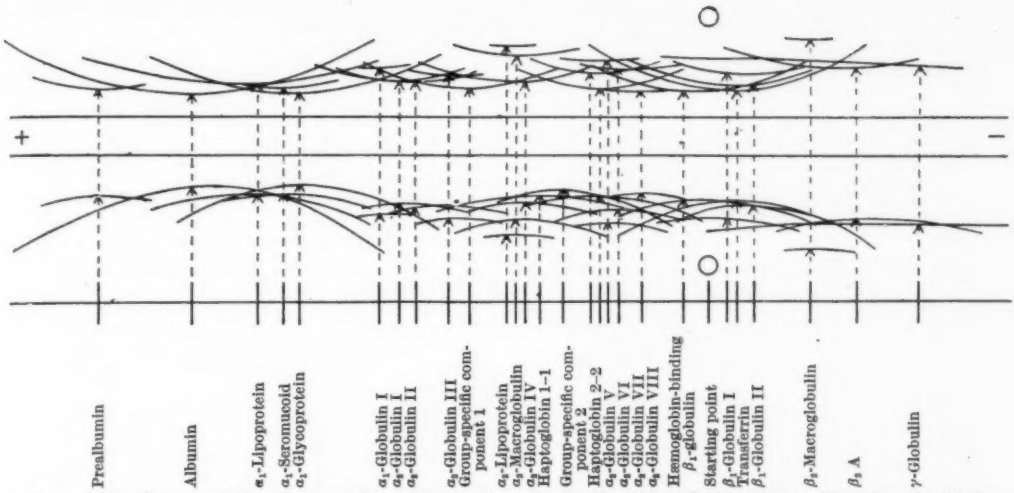


Fig. 1. Schematic representation of immuno-electrophoretic pattern of serum No. 2 (upper basin) and serum No. 4 (lower basin) after previous addition of hæmoglobin developed with different anti-human immune sera

groups depending on other precipitating components occupying different electrophoretic positions in different sera[4].

Both these group-specific systems occur in the α_2-globulin region, as characterized by immuno-electrophoresis, and the homozygotes in both systems have either a fast-moving or a slow-moving component which occupies very close electrophoretic positions. The haptoglobin homozygotes have a slightly slower electrophoretic mobility than the corresponding homozygotes characterizing the other group-specific system. These differences are, however, very subtle. The haptoglobin heterozygote (Hp 2-1) occupies an intermediate electrophoretic position between the Hp 1-1 and 2-2 precipitates, whereas the heterozygote of the other group-specific system gives a precipitate with two peaks if the electrophoretic separation is sufficiently prolonged, the two peaks corresponding to the fast- and slow-moving homozygotes respectively[4].

The haptoglobin precipitates can also be differentiated morphologically from the precipitates formed by the group-specific components, for they present different shapes of precipitate[3,5] and also occupy different positions between the antigen–antibody diffusion centres. Thus the Hp 1-1 precipitate shows an extended shape and is situated close to the antibody diffusion centre, whereas the Hp 2-2 precipitate is normally curved and situated closer to the antigen diffusion centre. The precipitates formed by the group-specific components 1 and 2, on the other hand, are identical with respect to shape of the precipitate (normally curved) and diffusion positions (close to the antibody diffusion centre). Their diffusion position is closer to the antibody diffusion centres than Hp 1-1 and Hp 2-2.

Addition of hæmoglobin will result in a slower migration of the haptoglobins, while the electrophoretic mobilities of other serum components (including the group-specific components) are evidently unaffected (Fig. 2). Also, the haptoglobin precipitates can be stained by means of a benzidine reagent, while no staining is obtained of the other group-specific precipitates if hæmoglobin is added to the sera[3].

By means of agar-gel electrophoresis[6], the electrophoretic position of the haptoglobins can also be localized and compared with the haptoglobin precipitate in immuno-electrophoresis (Fig. 2), whereas as yet no demonstration of the other group-specific components has been obtained with electrophoretic techniques other than immuno-electrophoresis.

It may be difficult to group human sera according to any of the group-specific components because of the number of other precipitating components, especially in the α_2-globulin region, some of which may also vary in different sera[7].

Either an immune serum has to be used, which contains as few precipitating antibodies against other components in the α_2-globulin region as possible, or the immune serum has to be absorbed. Immune sera, which can be used without absorption in haptoglobin grouping or grouping of the other group-specific components in human sera, have been found to be uncommon when rabbits are immunized with whole

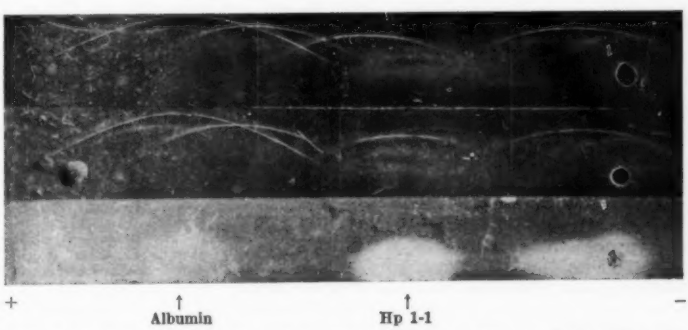
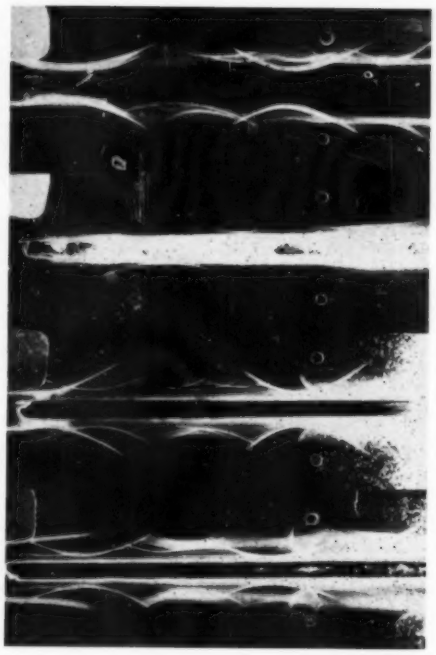


Fig. 2. Immuno-electrophoretic pattern of normal serum 4 before and after addition of hæmoglobin and agar-gel electrophoretic pattern of the same serum after addition of hæmoglobin and staining with benzidine (in order from above downwards)



Figs. 3–6. Immuno-electrophoretic pattern of serum No. 2 (upper basins) and serum No. 4 (lower basins) against immune serum *C*. 318.I (Fig. 3), and immune serum 275.IV after absorption with umbilical serum (Fig. 4), and different purified serum fractions (Figs. 5 and 6). For further explanation see text. The anode is to the left

human sera. Among about seventy immune sera prepared in rabbits by immunizing with human serum either with or without adjuvants only a few sera suitable for this purpose have been found[7]. On the other hand, most of these sera contained precipitating antibodies against the haptoglobins and the group-specific components, and also antibodies against several other components in the α_2-globulin region, which partially obscured the variations found in different sera. In Fig. 3 the immuno-electrophoretic pattern of two sera belonging to different haptoglobin groups developed with an untreated immune serum suitable for the demonstration of haptoglobin groups is shown, whereas in a previous communication the immuno-electrophoretic pattern developed with immune sera suitable for the demonstration of the other group-specific components were demonstrated[4].

As further possibilities of demonstrating group-specific components in a way suitable for routine grouping of human sera, a partial purification of the sera to be studied may be attempted. Work along these lines is in progress, but the results of such a technique are difficult to interpret on account of the possibility of changes occurring in electrophoretic or immunological properties of the components under study. Finally, specific staining methods might be used, but hitherto they have given results only for the haptoglobin precipitates.

In the present communication, simple absorption techniques will be presented by means of which it is possible to demonstrate the group-specific components, provided that an immune serum is available which contains precipitating antibodies against these components.

It has been found that this is the case for most rabbit immune sera immunized with normal human serum, and that such antibodies are also demonstrable in commercially available immune sera (Behring-Werke, No. 1047 and Institut Pasteur No. 13).

The absorption technique employed was first published by Dray and Young[8] but has also been used in our laboratory[2–5]. It will be referred to as intra-basin gel absorption.

All experiments were carried out with the same two sera from evidently normal blood-donors and Fig. 1 also refers to these sera. Serum No. 2 belongs to Hp 2-2 and group-specific component 1 (fast), whereas serum No. 4 is of the type Hp 1-1, group-specific component 2 (slow). Further data of these sera have been given in a previous communication[4]. No changes in these sera have been observed in repeated bleedings of the blood-donors during a period of a year.

In Fig. 1, a schematic drawing is made of the immuno-electrophoretic pattern of these sera when developed with five different immune sera in different experiments. The schematic drawing is believed to demonstrate all components accurately from the original photographs. In this instance, hæmoglobin was added to the sera, which explains the slower electrophoretic position of the haptoglobin precipitates than in Figs. 3–6.

In Fig. 3 the immuno-electrophoretic pattern of these sera is shown when developed with an untreated immune serum which incidentally contained strongly precipitating antibodies only against the haptoglobins and α_2-macroglobulin in the α_2-globulin region.

This immune serum also gives strong precipitates with albumin, transferrin, β_1-globulin 1, γ-globulin as well as another component in the γ-globulin region, which appears only in very fresh sera and disappears after a few weeks, even when sera are stored in the deep-freeze[7] (not included in the diagram).

In Fig. 4, the immuno-electrophoretic pattern of these sera is shown after intra-basin gel absorption with umbilical serum[2–5]. Only the haptoglobin precipitates are shown in the α_2-globulin region.

Intra-basin gel absorption of the immune serum with equal amounts of properdin (1·2 mgm./ml.) and fibrinogen (20 mgm./ml.) gives only the haptoglobins, the group-specific components α_2-macroglobulin as well as α_2-globulin IV, which recently has been identified as the cœruleoplasmin precipitate, in the α_2-globulin region (Fig. 5).

Finally, by means of intra-basin gel absorption with equal amounts of properdin (1·2 mgm./ml.) and albumin (70 mgm./ml.) the group-specific components can be demonstrated, whereas the antibodies against the haptoglobins seem to have been effectively absorbed (Fig. 6).

The serum fractions used were supplied by Kabi, Ltd., Stockholm.

I acknowledge grants from Karolinska Institutet and Stiftelsen Thérese and Johan Anderssons Minne.

[1] Grabar, P., and Williams, C. A., *Biophys. Biochim. Acta*, **10**, 193 (1953).
[2] Scheidegger, J. J., *Int. Arch. Allergy*, **7**, 103 (1955).
[3] Hirschfeld, J., *Acta Path. Microbiol. Scand.* (in the press).
[4] Hirschfeld, J., *Acta Path. Microbiol. Scand.*, **47**, 160 (1959).
[5] Hirschfeld, J., *Nature*, **185**, 164 (1960).
[6] Hirschfeld, J., *Acta Path. Microbiol. Scand.*, **47**, 169 (1959).
[7] Hirschfeld, J. (unpublished work).
[8] Dray, S., and Young, G. O., *Science*, **129**, 1023 (1959).

CLEAVAGE OF HUMAN γ-GLOBULIN

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TWO communications appearing recently in *Nature*[1,2] prompt us to report briefly our own experiences with the 'spontaneous' and enzymatic cleavage of human γ-globulin and other serum components.

During attempts to distinguish reaginic from non-reaginic sera by micro immuno-electrophoresis[3] we observed variations in human sera which were unrelated to allergy. Four out of twenty sera stored at 4° C. for 5–8 years shared a pronounced post-γ-globulin component when tested against antiserum (rabbit) to whole human serum (*R*72) and a further ten sera of this batch had a suggestion of a post γ-globulin line. Out of thirty-four sera stored up to four months at 4° C. only one showed the beginning of a split in the γ-globulin line. Thus, the γ-globulin of serum as well as that of plasma[1] shows evidence of spontaneous splitting during prolonged storage. There were also great variations in the strength of the β_{2M}-globulin line, in the number and positions of the β_1-globulins, the α-globulins and the appearance of a pre-albumin line, most probably identical with Grabar's ρ (ref. 4). Many more sera contained ρ than post-γ-lines, and more sera giving weak β_{2M}-lines had ρ-lines than sera giving strong β_{2M}-lines.

Further, two γ-globulin preparations obtained by fractionating serum on diethylaminoethyl-cellulose[5] originally gave only one line when tested with either rabbit antiserum to whole human serum (*R*72) or with rabbit antiserum specific for γ-globulin only (*R*92). After only a few weeks at 4° C. immuno-electrophorectic patterns showed three partially related γ-globulin components very much like those observed by Grabar[4] and Škvařil[1] in some stored γ-globulin preparations. Like Škvařil[1], we followed up these leads by deliberate proteolytic digestions.

By fractionation on diethylaminoethyl-cellulose we succeeded in preparing immuno-electrophoretically pure water-soluble γ-globulins of a limited range of medium electrophoretic mobilities. These were digested with papain using 1 mgm. of the crystalline enzyme per 100 mgm. of protein. Drops of the digest were removed at intervals and immediately subjected to immuno-electrophoresis. Five- and 17-hr. samples (37° C.) were also dialysed in the cold against distilled water before electrophoresis, but patterns before and after dialysis were identical. Forking at both ends of the γ-globulin line was observed immediately after adding the papain, but a distinct post-γ-line formed rather earlier than the pre-γ-line.

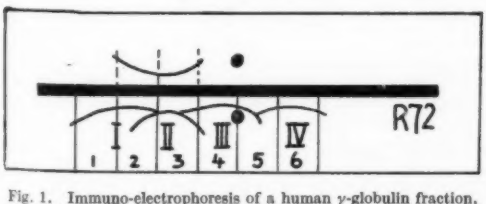

Fig. 1. Immuno-electrophoresis of a human γ-globulin fraction, undigested (top) and digested (bottom). For the Ouchterlony tests in Fig. 2 digests were electrophoresed in both the top and bottom halves; the gel in the top halves was cut into sections as indicated, the immuno-electrophoretic pattern in the bottom half being allowed to develop as usual to provide the key for the cut-out gel sections

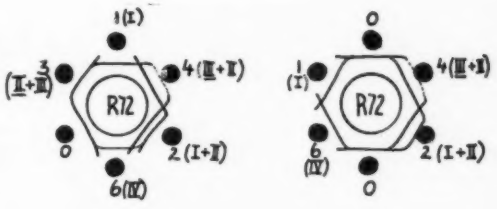

Fig. 2. Ouchterlony patterns obtained with γ-globulin digest fractionated by gel electrophoresis as indicated in Fig. 1. Arabic figures identify the gel sections while the roman figures in the brackets indicate the γ-globulin fraction in the particular gel section as identified by the immuno-electrophoretic pattern in Fig. 1. *O* = original undigested γ-globulin. *R*72 = rabbit antiserum to whole human serum

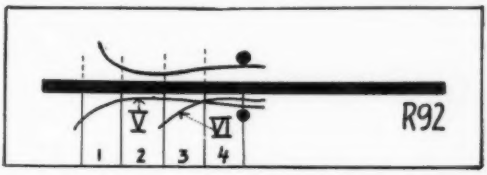

Fig. 3. Immuno-electrophoresis of undigested (top) and digested (bottom) whole human serum. *R*92 = rabbit antiserum to human γ-globulin only. For comparing the split products V and VI with those of Fig. 1, the gel was cut as indicated

There were three distinct components after 1 hr., the amounts of post-γ-globulin line (I) and especially the pre-γ-globulin line (III, Fig. 1) increasing at the expense of II during further digestion. A fourth component (IV) started to appear on the anode side after 4 hr. of digestion; Fig. 1 gives the picture obtained with *R*72 after 17 hr. No component IV could be seen when *R*92 was used to develop the pattern. The upper halves of the gel of three microscope slides were cut into six sections (as indicated in Fig. 1) immediately after finishing the electrophoresis and before the addition of the antiserum, as in methods described previously[6]. The cut-out gel sections were filled into peripheral cups of Ouchterlony plates as indicated in Fig. 2. From the immuno-electrophoretic patterns it was already clear that both I and III were partially related to II, and that IV was partially related to III. This was confirmed in the Ouchterlony tests (Fig. 2), which further showed complete immunological identity between II and the undigested γ-globulin (Fig. 2*A*), and partial identity of I, III and IV with undigested γ-globulin (Fig. 2*B*). Further, I gave a reaction of non-identity with both III and IV (Fig. 2). Also, it can be seen (Fig. 2*A*) that I

gave a reaction of complete identity with II after the elimination of antibodies specific for the determinants in III through precipitation in the line formed by III. Similarly, III gave a reaction of identity (Fig. 2*A*) with II due to the antibodies that had passed the precipitation line formed by I, that is, which lacked antibodies to the determinants specific for I.

Grabar[7] credits Scheidegger and Burtin with having evidence for five (and possibly seven) different determinants in human γ-globulin. The evidence presented here can be interpreted by postulating a minimum of three determinants, *A* on I, *C* + *B* on III, and all three of them on II. IV may be a split product of III and need contain only one determinant of III, for example, determinant *C*. No component IV appeared with *R*92, which must therefore have lacked antibody to *C*.

Only two γ-globulin fragments (V and VI, Fig. 3) were obtained after a 17-hr. digestion of whole serum when tested with *R*92. They proved to be immunologically identical with I and III above. There was no evidence of residual undigested γ-globulin.

Testing of whole serum digests with *R*72 showed little attack on proteins other than γ-globulin for 4 hr. Then a pre-albumin line appeared; after 17 hr. albumin was split into two related fragments and (from other evidence) fragmentation also occurred in the α-globulins.

The spontaneously split γ-globulins in sera stored for prolonged periods never showed more than two components (*R*92). These differences (between the digestion of isolated γ-globulin and γ-globulin in whole serum) could be due to our isolated γ-globulins (of a limited range of mobilities) containing more of the determinants *B* and *C* than of *A*, while the amounts of those two sets of determinants may be more nearly equal in the whole γ-globulin range.

A digest of rabbit γ-globulin prepared according to Porter[8] showed no immunological similarities when compared with our digest from human γ-globulin; *R*72, *R*92, a sheep antiserum against whole rabbit antiserum and a rabbit antiserum (*R*89) against an ultracentrifugally enriched macroglobulin fraction (from a Waldenstron patient) were used in the Ouchterlony comparisons.

With normal human sera and with γ-globulin fractions isolated from them, *R*89 gave what looked like three parallel γ-globulin lines, a heavy line flanked by two weak ones. This is reminiscent of the two γ-globulin lines obtained by Goodman[2] with chicken antiserum and whole human serum and may mean that even the purest γ-globulin preparations isolated so far contain components other than γ-globulin, but with identical electrophoretic mobilities.

[1] Škvařil, F., *Nature*, **185**, 475 (1960).
[2] Goodman, M., *Nature*, **185**, 474 (1960).
[3] Scheidegger, J. J., *Int. Arch. Allergy*, **7**, 103 (1955).
[4] Grabar, P., "Adv. in Protein Chemistry", **13**, 1 (1958).
[5] Augustin, R., and Hayward, B. J., *Immunology*, **3**, 45 (1960).
[6] Augustin, R., *Immunology*, **2**, 230 (1959).
[7] Grabar, P., *Ann. Inst. Pasteur*, **97**, 613 (1959).
[8] Porter, R. R., *Biochem. J.*, **73**, 119 (1959).

FOLLICLE REMAINS IN SOME BRITISH PARCHMENTS

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THE success obtained in the histological examination of parchment from the Dead Sea Scrolls[1] stimulated the generous provision of material for further work described below.

The earliest sample examined (Table 1) dated 1193, came from a collection of English parchments belonging to Mr. T. H. Gardner of Ampthill, Bedfordshire, samples of which were supplied by Dr. R. Reed, of the Department of Leather Industries, University of Leeds[2]. The only thirteenth-century samples were 6 from this collection. The fourteenth, fifteenth and sixteenth centuries were covered by 5 samples from the Public Record Office, 3 from Canterbury City Archives (via Dr. Reed) and a large collection from Yorkshire and Scotland. The Yorkshire samples were supplied by Mr. R. F. Dell when he was archivist of Leeds Central Library. They comprised samples from Fountains Abbey, the Royal Manor of Hatfield, and Sherburn in Elmet. Mr. Dell was much interested in this co-operation between humanistic and scientific disciplines; he made a great effort to ensure that the samples were of the greatest scientific value by using dated parchment from a known locality, while making sure that no part of a document that had been, or could have been written upon, was sampled, and that the exhibitional value was not impaired. Court rolls met all these requirements; series of dated parchments are available which were almost certainly acquired locally, and in a court roll there is often a considerable area of unwritten parchment at the junction of membranes from which the required short strip about 1 cm. wide could be taken without spoiling its appearance. In addition, a sample was sometimes taken from the end of a sealing tag. In fact, all the Scottish samples were of this nature. These were supplied by Mr. J. H. Thornton, of Northampton College of Technology, and covered the fifteenth, sixteenth and seventeenth centuries.

The final parchments examined were 164 from the family documents of Captain Sir Hugh Rhys Rankin, Bart., of Bryngwyn, near Kington, Herefordshire. These ranged in date from 1743 to 1871, and all the 60 dated before 1800 were examined; but there were so few remains in the nineteenth century parchments that only three from each decade were examined. Most of this collection were from documents that had been drawn up in Hereford, but there were some from various parts of England and Wales. However, certainly as early as the seventeen-nineties, it was clear that the parchment had not necessarily been made locally; one parchment from Hereford, in fact, bore the name of a London stationer.

The parchments were treated in the following way: Sandison's softening fluid[3], 24 hr.; 70 per cent alcohol, 3 hr.; 90 per cent alcohol, 3 hr.; absolute alcohol, 5 min.; carbolic xylol (phenol 25 gm.,

Table 1. Species or Wool Type in Parchments, Each Sample being indicated by its Date
Key: —, unidentified; f, fine; f–m, fine to medium; m, medium

Century	England (T. H. Gardner)	Public Record Office, London	Canterbury City Archives	Sherburn-in-Elmet	Hatfield, Yorks.	Fountains Abbey	Scotland	Hereford
12th	1193 m							
13th	1217 f 1244 — 1220 m 1274 ? Soay 1231 f–m 1297 f							
14th	Others not yet examined	1305 ? Soay 1387 see text and Fig. 2		1346 hairy 1365 hairy 1374 — 1376 f 1381 — 1386 — 1393 ? Soay	1328 f–m ? long 1338 —	1350 f 1350 f–m 1350 f–m 1350 hairy		
15th	Others not yet examined	1422 fat, and pigmented follicles ? calf 1462 m	1450–7 m ? long 1474 —	1402 f 1490— 1494 f–m 1496–98 —	1403 hairy (Fig. 1) 1431 —	1450 calf (book cover) 1495 —	1406 — 1452 — 1490 —	
16th	Others not yet examined	1527 hairy	1502 f–m ? down	1501 — 1505 f–m 1506 m 1507 — 1508 — 1511 f–m ? down 1513 m ? long 1514 — 1515 — 1516 — 1520 —	1540 — 1540 — 1540 —	1509 — 1511 f–m 1524 — 1535 — 1537 f–m	1519 ? Soay 1529 — 1538 — 1539 — 1563 — 1574 ? Soay 1580 ? Soay 1584 — 1594 ? Soay 1597 *a* ? Soay *b* m	
17th	1659 m 1677 m 1687 —		1692 f (described by Ryder, ref. 1)	Otley, Yorks. (Leeds City Museum) 1689 m ? long			1603 ? Soay 1618 — 1621 — 1624 — 1661 ? Soay 1664 ? Soay	
18th	1700 — 1702 — 1736 m			Startforth, Yorks. (Leeds Central Lib.) 1727 goat				1743 hairy sheep or goat—2 hairy sheep—1 medium—11 (1 ? long, but all could be) f–m—1 m— 2
19th								1871

xylol 75 ml.), overnight, and then wax embedded *in vacuo* for 30 min. They were sectioned horizontally, that is, parallel to the original skin surface, and stained with sacpic stain[4].

Only one sample had a clear follicle grouping, whereas four of the Dead Sea Scroll samples[1] had clear groups. Even those with many well-preserved follicles or fibres did not show the follicle arrangement. The remains in the medieval parchments were on the whole less well preserved than those in the Dead Sea Scroll parchments, possibly owing to the wetter British climate, although many of the medieval parchments were of excellent quality. The seventeenth- and eighteenth-century parchments were on the whole of the worst quality, being the thickest, but showed most histological detail, for example, cell nuclei in follicle bulbs and surface scale patterns on the wool fibres. The nineteenth-century parchments were the thinnest, and contained the least number of remains.

The results are summarized in Table 1. Identification presented great difficulty because it had to be based mainly on individual follicles and fibres. The main criterion was the diameter of fibres and follicles, resulting in descriptions as fine, medium, and fine to medium wool, which gave no indication of breed. Sometimes, however, further information could be obtained from indications of follicle grouping and fibre-scale pattern, and suggestions of type, for example, down or long-wool, were added. A further difficulty was the likelihood that sheep of the past differed from those of to-day; for example, the mention of down sheep means that the sample had the appearance of this type, and not necessarily that the down type existed at that date. Hairy sheep were easily distinguished because of the presence of both coarse and fine fibres, the latter having a large latticed medulla (Fig. 1). They were distinguished

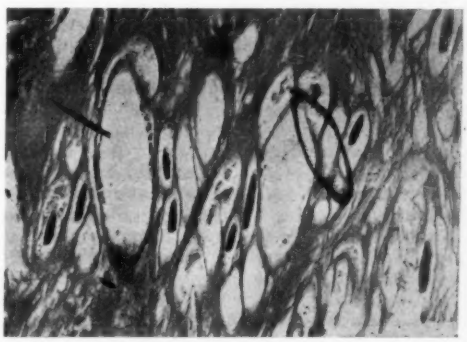

Fig. 1. Parchment from hairy sheep; note coarse fibre with latticed medulla displaced from primary follicle, and fine fibres in secondary follicles. × 55

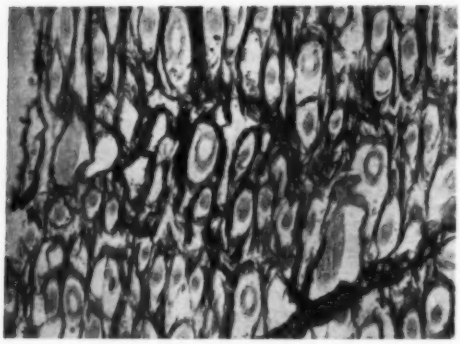

Fig. 2. Parchment with unidentified fibres. × 60 (see text)

from goats by the extremely large size of the latticed medulla, and the somewhat larger size of the secondaries in sheep. A single sample from Startforth, Yorkshire, was identified as goat from the scale pattern of the fibres actually remaining above the parchment surface. Every Scottish sample had pigmented follicle bulbs, which, as with other pigmented samples, at first suggested calf. Later, however, it was realized that the pigmented fibres present in some of the other samples closely resembled those of the primitive domestic Soay type of sheep[1,5], and that these too could have been from the Soay. One sample from the Public Records Office dated 1387 could not be identified, although it had very clear fibre remains (Fig. 2). These were sparsely pigmented, as in the Soay, but the appearance was not characteristic of sheep. The medullæ were wider than usually found in the calf, being the size often found in the goat, but lacking the latticed structure characteristic of wide medullæ, and the secondaries were larger than usually found in the goat. Many of the fibres had brush ends showing that they had been about to moult.

Hairy sheep were apparently present in all periods, whereas most of the fine-wool samples came from the medieval period, and most of the medium-wool samples came from the sixteenth century onward, those of the eighteenth century being the coarsest. The findings therefore support historical records which mention the extreme fineness of medieval wool, and also work which has shown evidence of an increased supply of long wool during the sixteenth- and seventeenth centuries[6]. There was evidence, however, of the existence of medium and fine-to-medium wool sheep in the Middle Ages that could have been the ancestors of the long-wool, the origin of which has recently been much discussed[6–8]. It is interesting that a suggestion of Soay sheep was found in Scotland, because it had been thought that the Soay type was widespread there until the eighteenth century.

I wish to thank all those mentioned earlier who provided the material for this work, which was carried out while I was a member of the staff of the Wool Industries Research Association, Leeds. I am grateful to Miss R. G. Jasper for technical assistance.

[1] Ryder, M. L., *Nature*, **182**, 781 (1958).
[2] Burton, D., Poole, J. B., and Reed, R., *Nature*, **184**, 533 (1959).
[3] Sandison, A. T., *Stain Tech.*, **30**, 277 (1955).
[4] Auber, L., *Trans. Roy. Soc. Edin.*, **62**, 191 (1952).
[5] Ryder, M. L., *Nature*, **183**, 1831 (1959).
[6] Bowden, P. J., *Econ. History Rev.*, ii, **9**, 44 (1956).
[7] Ryder, M. L., *Agric. History Rev.*, **7**, 1 (1959).
[8] Ryder, M. L., "Sheep Breeds in History", in Year Book of the National Sheep Breeders' Assoc. (in the press).

HIND-LIMB REFLEXES IN THE KITTEN

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Velocity of Conduction and Spinal Transmission of Proprioceptive Hindlimb Reflexes

MALCOLM[1,2] studied the transmission of proprioceptive hind-limb reflexes and the postnatal development of their facilitation and inhibition in kittens. With regard to the conduction of these reflexes, Malcolm states that many fibres are only partly medullated and nonconducting[2], and says nothing of the time relationships in the reflex arc. He concluded that the potential transmitted over the cord is monosynaptic because it is a single synchronous volley without after-discharge. Hursh[3] studied the properties of growing nerve fibres and related the increasing velocity of conduction of a skin nerve to the increasing length of the leg during development. From this he concluded that, so far as the peripheral nerve is concerned, the movements of the kitten are not slowed because of the decreased rate of conduction, since the latter is nicely compensated for by the decreased length of the nerve path. This conclusion has been further extended by Lloyd[4], who presumed that the transmission through the spinal cord is not slower in the new-born animal than in the adult.

It will here be shown that both the peripheral conduction and the central transmission of proprioceptive hind-limb reflexes are slower in the new-born kitten than in the adult animal, until the kitten reaches the age when it can walk and stand on its hind-legs. Furthermore, it is concluded for several reasons that the spinal transmission of proprioceptive reflexes is monosynaptic.

Experiments have been performed on kittens from 60 different litters, most of them ranging in age from 1 to 45 days. They were either decerebrated and spinalized or anæsthetized with nembutal intraperitoneally (35 mgm./kgm. body-weight). Various hind-limb nerves were dissected free for stimulation and recording, and after laminectomy either all dorsal or all ventral roots from *L*II and downwards were severed for recording or stimulation. This preparation has been used both for determining the velocity of conduction and the spinal transmission of proprioceptive reflexes as well as their reaction to antidromic and tetanic stimulation, and their facilitation and inhibition. Furthermore, the Renshaw feedback

and the impulse-flow from sense organs in the muscle have been studied. Here only the development of the time relationships in the proprioceptive hind-limb reflexes will be considered.

At birth, the velocity of conduction of the fastest muscle afferents varies in different litters and animals from 8 to 12 m./sec., which means a time of conduction of around 3–4 m./sec. from, say, the gastrocnemius muscle to the spinal cord, the distance varying from 3·5 to 4·5 cm. When the kitten is well able to support its body-weight on the hind-legs, the velocity of conduction of the fastest muscle afferents has increased to about 30 m./sec. At the same time the distance has increased to 5–8 cm. from the gastrocnemius, which means a time of conduction of around 3 msec. This velocity of conduction is normally attained at an age of 18–25 days postnatally.

The ventral roots and muscle efferents are developed earlier than the dorsal roots and muscle afferents, having a velocity of conduction that is 2 m./sec. faster in the new-born animal. When the efferents have achieved a velocity of about 30 m./sec., there appears a later wave in the neurogram on stimulation at ten times threshold for the biggest efferents. This wave has been found to correspond to the gamma-efferents in the adult nerve.

On stimulating a muscle nerve or a dorsal root and recording on the central end of the cut ventral root, a rather synchronous potential is obtained in the new-born kitten (Fig. 1). With increasing age the reflex time is seen to diminish, so that, at a velocity of peripheral conduction of 30 m./sec., it is about the same as that of the monosynaptic potential in the adult animal[5–7]. Such a long reflex time as that in the new-born kitten does not immediately suggest that it is mediated by a two-neuron arc. The flexor behaviour of the animal[8] suggests rather that the reflex is polysynaptic and directed to the flexors. This possibility can be immediately ruled out, for on stimulating the dorsal roots and recording on the muscle nerves, or both stimulating and recording on the muscle nerve, a reflex with the same central delay can be recorded on both extensor and flexor nerves. Thus, so far its identity with the monosynaptic reflex is clear. In Fig. 2 the reflex time on stimulating the dorsal and recording on the ventral root has been plotted against velocity of conduction in the muscle afferents (circles). Subtracting the time of conduction in the dorsal and ventral roots gives the curve with half-filled circles. Measurements on spinal cord sections in a new-born kitten have shown that the intraspinal conduction path to the ventral horn cells amounts to 2 mm. in S 1. Plotting the time of conduction in the dorsal root collaterals kept at a constant length of 2 mm. against velocity of conduction in the muscle afferents, the velocity of intraspinal conduction being assumed to be a third of that for the adult animal gives the filled circles. From these curves is seen that, with a synaptic delay of 0·5–0·8 m./sec.[4], there would be no time for more than one synapse. The velocity of conduction in the thin dorsal root collaterals might be even slower in the new-born kitten than the calculated value, and the conduction path is somewhat longer than 2 mm. at the later stages of development, which would shift the filled circles to the right, as the time of intraspinal conduction from the ventral horn cells to the surface of the cord, here not calculated, will do. It is thus concluded that the reflex is mediated by arcs of two neurons already in the new-born animal, the long reflex-time being due to the slow velocity of conduction, although a somewhat longer synaptic delay than in the adult animal might be at hand.

From these experiments it is seen that the stretch reflex loop approaches the same time relationships

Fig. 1. Reflex potential recorded on the central end of the cut ventral root in three different experiments, (1), (2), (3), on stimulation of the gastrocnemius nerve in the popliteal fossa, afferent nerve path 4·7 cm., 5·4 cm. and 6·8 cm., respectively; (4), (5), (6), on stimulation of the cut dorsal root S 1, (1) and (4) from 1-day old kitten, (2) and (5) from 12-day old kitten, (3) and (6) from 28-day old kitten. Time, 1,000 c./sec. Note shock artefacts appearing one under the other

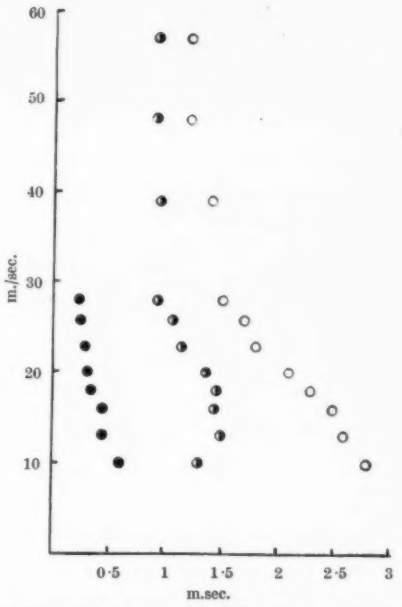

Fig. 2. Reflex-time on stimulation of the dorsal root and recording on the ventral root S 1 plotted against the velocity of conduction of the muscle afferents in 11 experiments (circles). The central reflex-time plotted against velocity of conduction of the muscle afferents in the same 11 experiments (half-filled circles). Time for dorsal root collateral conduction plotted against velocity of conduction of the muscle afferents up to 28 m./sec. (filled circles). For further explanation see text

as in the adult animal when the velocity of peripheral conduction has reached 30 m./sec., which occurs on the eighteenth to twenty-fifth day postnatally. It has earlier been found[8,9] that decerebrate rigidity and tonic stretch reflexes appear in the hind-limbs at that time.

[1] Malcolm, J. L., Abstr. Nineteenth Int. Physiol Congr., Montreal, 586 (1953).
[2] Malcolm, J. L., in "Biochemistry of the Developing Nervous System", 104 (Acad. Press, Inc., New York, 1955).
[3] Hursh, J. B., *Amer. J. Physiol.*, **127**, 140 (1939).
[4] Lloyd, D. P. C., in "Textbook of Physiology", seventeenth edit., 57, Fulton (W. B. Saunders Co., Philadelphia and London, 1955).
[5] Eccles, J. C., and Pritchard, J. J., *J. Physiol.*, **89**, 43*P* (1937).
[6] Renshaw, B. B., *J. Neurophysiol.*, **3**, 373 (1940).
[7] Lloyd, D. P. C., *J. Neurophysiol.*, **6**, 293 (1943).
[8] Skoglund, S., Kungl. Vetenskapssamhällets i Uppsala Årsbok, **3**, 75 (1959).
[9] Skoglund, S., *Uppsala läkaref. förh.*, **1–2**, 92 (1959).

Properties of the Two-Neuron Arc

In a series of investigations, Granit and collaborators[1–3] have shown that post-tetanic potentiation[4,5] elicited either by electrical stimulation or repeated pulls on a muscle facilitates certain motoneurones called tonic to respond with a series of impulses, which can be elicited at the height of the post-tetanic potentiation. Ordinarily these events are brought about by the gamma activation of the nuclear bag endings driving them to frequencies high enough to set up a state of residual facilitation or post-tetanic potentiation[1,2]. It will here be shown that the monosynaptic pathway in the kitten has properties, except for its slow conduction through the cord, which seem to prevent the creation of facilitations of long duration. Thus post-tetanic potentiation is lacking and develops simultaneously with facilitation between synergists.

Experiments have been performed on kittens 1–45 days of age as described in the preceding communication.

The first thing observed when eliciting the monosynaptic reflex in a newborn kitten is that it has a longer recovery time than in the adult animal[6]. To obtain the reflex at its full size, up to seven seconds between the shocks is necessary. When usually eliciting the reflex every third second, the first two or three reflex potentials are bigger than the following ones. The reflex cannot be observed if it is elicited more frequently than 1/sec. Testing the recovery of motoneuron excitability after an antidromic shock to the ventral root shows complete recovery within 100 msec. (ref. 6). It is thus concluded that the long recovery-time in conformity with the long central reflex-time is presynaptic in character. When the velocity of peripheral conduction for the muscle afferents has reached 30 m./sec., the monosynaptic reflex shows about the same recovery time as in the adult animal.

Applying a supramaximal tetanic stimulation to the muscle afferents for varying times from 3 to 30 sec. with a frequency of 25–550 impulses/sec. is not, as in the adult animal, followed by post-tetanic potentiation[5] (see Fig. 1). Instead the potential disappears completely for a period of 2–4 sec. after the tetanization, the time varying with the duration and frequency in the same manner as in the adult animal[5]. When the potential reappears, it has an increased central latency up to 3 msec. Then during a period of 30–50 msec. it usually resumed the control latency,

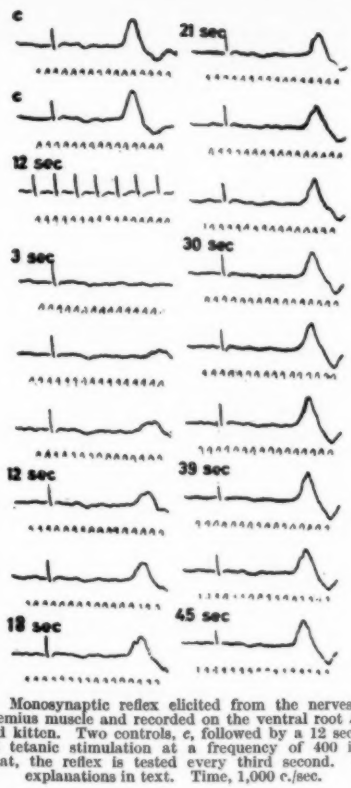

Fig. 1. Monosynaptic reflex elicited from the nerves to the gastrocnemius muscle and recorded on the ventral root *S* 1 in a 1-day-old kitten. Two controls, *c*, followed by a 12 sec. supramaximal tetanic stimulation at a frequency of 400 imp./sec. After that, the reflex is tested every third second. Further explanations in text. Time, 1,000 c./sec.

the potential being restored somewhat earlier (see Fig. 1).

With advancing age the increase of latency after tetanization, as well as the time required before latency and the height of the potential have resumed their control value, diminish. When the velocity of peripheral conduction has exceeded 20 m./sec., the first signs of a post-tetanic potentiation appear in response to a short tetanus, a long tetanus still setting up an increase of latency and diminution of the potential for quite a considerable time.

Post-tetanic potentiation is well developed when the conduction velocity of the muscle afferents has reached 30 m./sec. 18–25 days postnatally. At this stage of development short tetani also give facilitation of potentiation[1].

These experiments have provided information on the postnatal development of the dorsal root collaterals and events concerned with post-tetanic potentiation. Here, however, I wish to stress only the simultaneous development of post-tetanic potentiation and other adult features of the monosynaptic pathway on one hand, and decerebrate rigidity and tonic stretch reflexes[7,8] on the other.

[1] Granit, R., *J. Physiol.*, **131**, 32 (1956).
[2] Granit, R., Henatsch, H.-D., and Steg, G., *Acta Physiol. Scand.*, **37**, 114 (1956).
[3] Granit, R., Phillips, C. G., Skoglund, S., and Steg, G., *J. Neurophysiol.*, **20**, 470 (1957).
[4] Larrabee, M. G., and Bronk, D. W., *J. Neurophysiol.*, **10**, 139 (1947).
[5] Lloyd, D. P. C., *J. Gen. Physiol.*, **33**, 147 (1959).
[6] Eccles, J. C., and Rall, W., *J. Neurophysiol.*, **14**, 353 (1951).
[7] Skoglund, S., Kungl. Vetenskapssamhället i Uppsala Årsbok, **3**, 75 (1959).
[8] Skoglund, S., *Uppsala läkaref. förh.*, **1–2**, 92 (1959).

LETTERS TO THE EDITORS

PHYSICS

Effect of Specular Reflexions on the Radiation Flux from a Heated Tube

A QUESTION of some importance that arises in problems of radiational transfer of energy in an enclosure is this: If ε is the emissivity, and hence also the absorptivity, of the surface, in what manner is the fraction $(1 - \varepsilon)$ of the incident radiation that is not absorbed returned to the enclosure? In most investigations on the radiation from the inside of a uniformly heated cylinder it is assumed that the whole of this fraction is diffusely radiated according to the cosine law[1]. The alternative case where the whole of this fraction is specularly reflected does not seem to have been investigated. This case also is of interest, since it can be secured in practice by suitably polishing the wall surface, and secondly since it lends itself to a more precise and elegant theoretical treatment than the corresponding case of perfectly diffuse reflexion.

Consider, for example, the flux of radiation that issues from the mouth of a cylinder, open at both ends, the temperature of which is kept uniform over its whole length. In order to evaluate the flux one may adopt a method somewhat similar to that used by Berman, Simon and Ziman[2] for calculating the effect of specular reflexions of thermal phonons of long free path from the walls of a cylindrical crystal on its thermal conductivity at low temperatures—though these authors were concerned, unlike here, with transport of energy under a gradient in temperature. The flux can be readily shown to be equal to:

$$F_L = \sigma T^4 \sum_{r=0}^{\infty} \varepsilon^2 (1 - \varepsilon)^r \int_0^L \mu\left(\frac{h}{r+1}\right) dh \qquad (1)$$

where:

$$\mu(h) = \pi\left[h - \frac{2h^2 + D^2}{2(h^2 + D^2)^{1/2}}\right] \qquad (2)$$

σ being Stefan's constant, L the length of the tube and D its internal diameter.

When the tube is long, that is, when $L \to \infty$, the expression for the flux reduces to:

$$F_\infty = \sigma T^4 \varphi(\varepsilon) \int_0^\infty \mu(h') dh' \qquad (3)$$

where:

$$\varphi(\varepsilon) = \sum_{r=0}^{\infty} \varepsilon^2 (1 - \varepsilon)^r (r + 1) \qquad (4)$$

is the factor by which the corresponding expression for the ideal case when the walls of the tube are black has to be multiplied in order to take into account the defect of actual ε from unity and the consequent occurrence of specular reflexions.

It can be readily seen that:

$$\varphi(\varepsilon) = \varepsilon^2[1 + 2(1 - \varepsilon) + 3(1 - \varepsilon)^2 + \ldots] = 1 \qquad (5)$$

That $\varphi(\varepsilon)$ is independent of ε and is equal to unity, as though the direct radiations only were involved and they corresponded to those of a black body, is significant. It can be further seen that $\int_0^\infty \mu(h) dh = \frac{1}{4}\pi D^2$, which is just the area S of the mouth of the tube, and that $F_\infty = S\sigma T^4$, which is just the radiation that one would expect from a black body of this area.

The equivalence of the flux from the mouth of the cylinder to the radiation from a black surface holds for all directions over the 2π solid angle.

When the other end of the tube is closed, the flux from the mouth includes, in addition to F_L, two more terms, F_L' and F_L'', relating to the radiations that originate from the side walls and are reflected from the end wall, and those that originate from the end wall, respectively:

$$F'_L = \sigma T^4 \sum_{r=0}^{\infty} \varepsilon^2 (1 - \varepsilon)^{r+1} \int_L^{2L} \mu\left(\frac{h}{r+1}\right) dh \qquad (6)$$

$$F_L'' = \sigma T^4 \sum_{r=0} \varepsilon^2 (1 - \varepsilon)^r \xi\left(\frac{L}{r+1}\right) \qquad (7)$$

where:

$$\xi(L) = \tfrac{1}{4}\pi[2L^2 + D^2 - 2L(L^2 + D^2)^{1/2}] \qquad (8)$$

With $\varepsilon = 0{\cdot}75$, the flux issuing from the mouth of a tube of length $5D$, closed at the other end, is short of that from a black body by about 1 per cent. In the alternative case of perfectly diffuse reflexion, even though the flux along some directions may approximate even more closely to that from a black surface, the total flux over all directions is considerably short of it, and remains so however much the cylinder may be extended.

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[1] See, for example, Buckley, H., *Phil. Mag.*, **4**, 753 (1927).
[2] Berman, R., Simon, F. E., and Ziman, J. M., *Proc. Roy. Soc.*, A, **220**, 171 (1953).

Gamma Irradiation of Lead Silicate Glass

GLASSES exposed to gamma radiation darken due to the trapping of electrons in defects. Much work has been done by Seitz and others on colour centres produced in alkali halides by irradiation. Glass has also been studied by many workers, and it is well known that the intensity of the colour produced in glass fades in the dark and that this process is accelerated by increase in temperature or by exposing the glass to light. The present work was undertaken to investigate the mechanism involved in the darkening of glass, and the recovery in the dark with time, in an attempt to obtain better understanding of the structure of glass. A lead silicate glass of weight percentage composition PbO–80, SiO_2–20 was chosen because of the simplicity of its chemical composition (approximately $PbO.SiO_2$). Such glass might be expected to provide a simple absorption spectrum after irradiation. Rectangular blocks of glass 1 cm. × 1 cm. × 3 cm. cut from a single

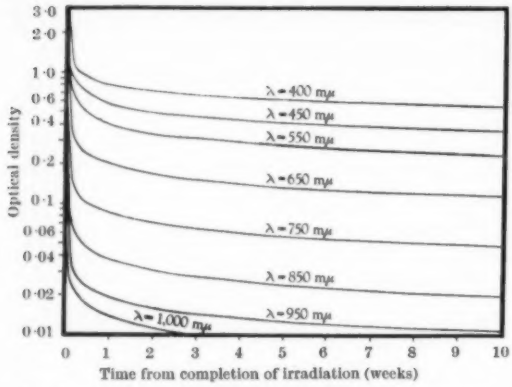

Fig. 1. Change in optical density with time for various wave-lengths; dose 10^6 rads

block of glass had their 1 cm. × 3 cm. faces ground and polished to be flat and parallel.

Since it was required to study the effect on glass of various doses of gamma radiation from 10^4 to 10^8 rads, use was made of the spent fuel-element radiation facility at the Atomic Energy Research Establishment, Harwell, this being the only facility capable of providing large doses in reasonably short times.

Pairs of glass samples were irradiated simultaneously so that each received the same dose. By variation of the time of irradiation, the dose was graduated in steps of $10^{0.5}$ between 10^4 and 10^8 rads. The difference in optical density between an irradiated and an unirradiated sample was measured directly. Fig. 1 shows the variation in optical density with time after completion of the irradiation for a dose of 10^6 rads. The optical density decreased rapidly immediately after removal from the radiation facility, and the rate of fading became smaller as time progressed. Similar curves obtained for other doses within the range studied had the same form.

The effect of increasing dose on optical density at different wave-lengths after certain periods of fading was studied. It was found that as the glass was irradiated, the number of colour centres increased rapidly at first with increasing dose, apparently approaching a saturation value. Complete saturation was not achieved, however, since for doses higher than 10^6 rads the variation between optical density and dose was linear. The explanation suggested for this is that there are two processes involved: trapping of electrons in defects existing in the glass prior to irradiation; and creation of defects of the same type during irradiation. These induced defects can then trap electrons to produce the same type of colour centre. The filling up of defects already existing is complete at about $10^{5.5}$ rads, but there is no evidence to suggest departure from non-linearity between the concentration of induced defects and dose up to 10^8 rads.

The absorption spectra of the irradiated samples show three absorption bands at approximately 1·7 eV., 2·3 eV., and 3·3 eV. If it is assumed that these absorption bands are Gaussian in shape, it is possible to separate the full absorption curve into three component parts shown as dotted lines in Fig. 2. Further work is in progress and will be reported elsewhere.

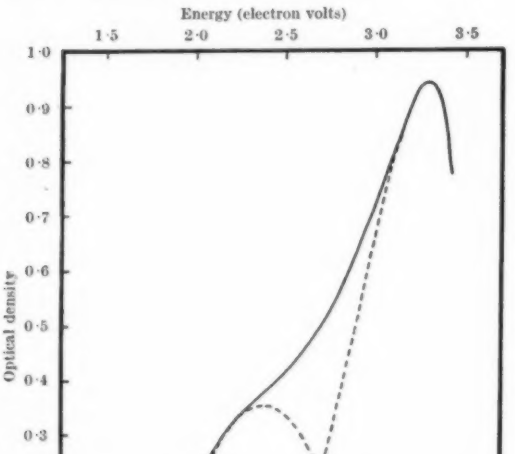

Fig. 2. Absorption spectrum of irradiated glass; dose 10^6 rads. 10,000 min. after irradiation

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Ultrasonic Velocities in Aqueous Electrolyte Solutions

In a recent communication, Mr. S. V. Subrahmaniam[1] has reported measurements of ultrasonic velocities in aqueous solutions of cadmium iodide and mercuric chloride. I have made a detailed investigation of the variation of ultrasonic velocities in a number of aqueous solutions of electrolytes with concentration and temperature. The electrolytes that show the rather unusual behaviour of decreasing sound velocity with increasing concentration are the following: (1) cadmium bromide, (2) cadmium iodide, (3) zinc iodide, (4) strontium iodide, (5) lead acetate, (6) uranyl chloride, and (7) uranyl nitrate. The detailed results were published[2,3]; the conclusions reached in those studies are as follows:

(1) While in general sound velocities in electrolyte solutions are greater than that of water and increase with increasing concentration at all temperatures the experiments on the above-mentioned electrolytes reveal the opposite type of behaviour, that is, a decrease in sound velocity with increasing concentration, the values being always less than that of water.

(2) It is also a striking feature that the velocity decrease is always associated with the presence of heavy ions like Pb^{++}, I^{-}, U^{++}, etc., so it is probable that a correlation exists between the two factors. It

has been suggested by Barthel[4] that in the case of heavy ions the velocity of Brownian motion is much less and this may result in a decrease in velocity, Brownian motion being regarded as one of the factors that contribute to the sound velocity.

(3) It is noteworthy, however, that the adiabatic compressibilities are quite normal in all these cases, being always less than that of water at all concentrations and temperatures.

(4) One more striking feature is that in spite of the anomalous variation in sound velocity a linear variation of apparent molar compressibility with square root of concentration is found in all cases as predicted by the Debye–Hückel theory.

(5) The slopes of the apparent molar compressibility versus square root of concentration curves and the values of apparent molar compressibility at infinite dilution do not show any marked correlation with decrease in velocity with increasing concentration.

(6) On the other hand, these properties seem to be related more to the state of dissociation of the electrolytes and the existence of complex ions.

The above work was carried out at the Indian Institute of Science, Bangalore, India, under the direction of Prof. R. S. Krishnan, head of the Physics Department, and I thank him for his kind interest and encouragement.

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[1] Subrahmaniam, S. V., *Nature*, **185**, 371 (1960).
[2] Balachandran, C. G., *J. Indian Inst. Sci.*, **37**, 27 (1955).
[3] Balachandran, C. G., *J. Indian Inst. Sci.*, **38**, 1 (1956).
[4] Barthel, R., *J. Acous. Soc. Amer.*, **26**, 227 (1954).

Perceptual Anomalies associated with a Single Contour

In the course of an investigation into the basis of 'complementary images'[1] evoked by patterns of near-parallel lines, I have observed some striking phenomena which, together with some confirmatory tests that they suggested, indicate that a single contour can be sufficient to excite a complementary image.

Two 300-W. projectors were focused on a screen at a distance of 1 metre. One of these, *A*, projected a plain bright field, while the other, *B*, projected a bright field with a black disk 10 cm. in diameter in the centre. By means of a rotating circular mask with two 10° apertures on opposite sides, these images were presented alternately, at intervals *AB* and *BA*, which could be varied by raising and lowering the axis of the mask. When the time-interval *AB* was about 30 per cent of the total cycle the following phenomena were observed. (1) Fine radial spokes extended about 2 cm. inwards from the edge of the dark disk. These were sharpest and brightest at the circumference, becoming more diffuse towards the centre. There were about 40 of them when viewed at 1 metre; (2) the disk appeared to be in continuous rotation of variable speed; (3) the disk gave the impression of slow continuous expansion; (4) the background was rather brighter and the disk considerably darker in the neighbourhood of the edge.

When the interval *AB* was 50 per cent of the cycle: (1) the radial effects were broader in appearance; (2) rotation was seen as before; (3) the disk remained constant in size; (4) the disk again appeared dark, but there were no variations in brightness towards the edge.

When the time-interval *AB* was increased to 70 per cent of the cycle: (1) The strongest radial effects were now on the outside of the disk and were described by most observers as spiky, but the disk showed diffuse internal rays. Again when viewed at 1 metre the effects extended about 2 cm. from the edge; (2) rotation was seen as before; (3) the disk now gave a compelling impression of continuous contraction; (4) the background was much brighter in the neighbourhood of the edge whereas the disk appeared uniform and considerably brighter than previously and was olive in hue.

With simultaneous presentation of *A* and *B* the disk was again of an olive shade and both this and its background appeared much brighter than in the other cases. Pattern and movement, however, were scarcely visible.

In all cases Fechner colours and 'stroboscopic' patterns[2] associated with flashing light (but unrelated to the pattern of the disk) were frequently noticed.

The phenomena were strongest for frequencies in the range of 15–25 cycles per sec. but persisted to some extent through the range of 5–40 cycles per sec.

Corresponding effects were observed using a bright disk on a dark ground and using a single straight edge, and again when a negative of the disk pattern was substituted for the plain field.

The effects were the same whether one or two eyes were used. The presentation of the plain field to one eye and the disk to the other, however, gave no comparable results.

In view of the apparent relation between these phenomena and the complementary image, a series of tests were undertaken to find out whether other methods used to evoke complementary images[1] might also be effective with a single circular contour.

As might have been expected, no convincing complementary pattern was seen as an after-image, though a few subjects have reported a very faint radial pattern. A more effective technique was found in altering the pattern brightness cyclically about once per sec., when at times a radial pattern could be seen clearly.

Simple stroboscopic illumination was also found to give unconvincing results with a single contour. When, however, flashing light was superimposed on a bright continuous image, corrugations could be seen on the darker side of the contour.

The movement seen in spatio-temporally random visual 'noise'[1] appeared more organized at the contour, although this effect was not comparable in magnitude to that produced by patterns of many lines.

Double flash stimulation of the type described above has also been found more effective in producing vivid and continuous complementary images of more complex patterns. The reason for this is not yet understood. It seems, however, that any theory of the complementary image must now account for its production at a single contour.

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[1] MacKay, D. M., *Nature*, **180**, 849, 1145 (1957).
[2] Smythies, J. R., *Brit. J. Psych.*, **50**, 106, 305 (1959).

Ultra-Violet Absorption Spectra of the Molecules H_2O, HDO and D_2O

The ultra-violet absorption spectrum of liquid water has been reported by various workers[1–4]. They found that absorption begins in the region of 200 mμ and increases with decreasing wave-length as far as the limit of measurement at 180 mμ.

In view of the renewed interest in the photochemistry of aqueous systems at wave-lengths less than 200 mμ, this spectrum has been re-investigated together with that of the molecules HDO and D_2O. The spectra of the purified materials were measured on a Hilger *H*700.308 'Uvispek' equipped with a silica prism transmitting down to 185 mμ.

At wave-lengths less than 195 mμ, it was found to be essential to render the entire optical path free from oxygen, the gas having strong absorption in this region[5]. This was done by modifying the instrument so that the optical system could be continuously flushed with oxygen-free nitrogen during measurements. Failure to observe this precaution led to spectra similar to those reported by Golding[6] being observed. In order that spectra could be observed at various temperatures, we have used a thermostatted cell-carriage in conjunction with Hilger high-transmittance 5-mm. and 1-cm. silica cells. Corrections for scattered light have been applied to all optical densities measured.

The spectra of H_2O, HDO and D_2O at 25° C. are shown in Fig. 1, and the corresponding spectra at 50° C. are shown in Fig. 2. The spectra of HDO were derived from the spectra of a 1 : 1 mixture of H_2O and D_2O, the fractions of HDO present being calculated on the basis of the equilibrium constants for the exchange reaction :

$$H_2O + D_2O \rightleftharpoons 2HDO$$

which have been reported by Urey[7].

As can be seen from the spectra, there are significant differences in the absorption coefficients of H_2O, HDO and D_2O at any given wave-length, and also the spectra are markedly dependent on temperature.

The shape of the spectrum of H_2O is in agreement with the previously reported work, but the value of

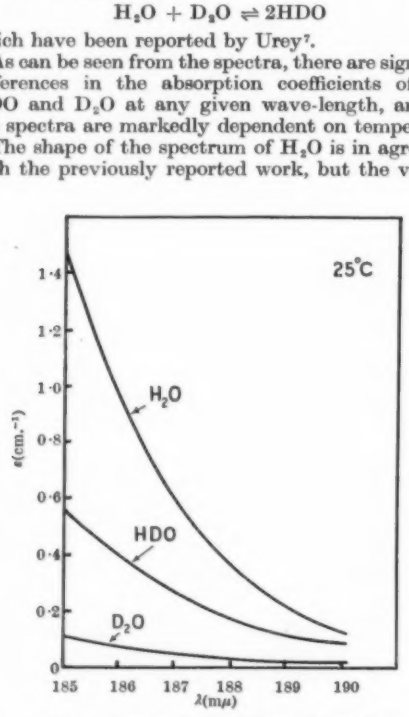

Fig. 1. Spectra of H_2O, HDO and D_2O at 25° C.

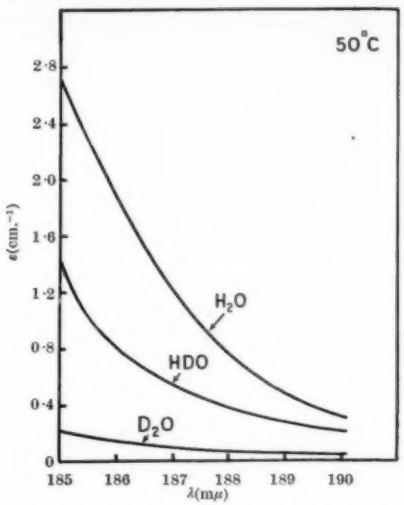

Fig. 2. Spectra of H_2O, HDO and D_2O at 50° C.

1·46 cm.$^{-1}$ for ε for water at 185 mμ at 25° C. is higher than the previously reported value of 1·2 cm.$^{-1}$ (ref. 8). This we consider to be due to the greater accuracy of the method and to the substantial correction for scattered light at this wave-length. The values for the absorption coefficients of H_2O, HDO and D_2O will be of use in the interpretation of results of photochemical investigations of systems containing these species.

The observed dependence on temperature has been noted by Golding[6]. We have investigated this effect in several systems in which hydrogen-bonding is known to be present.

We have found that the dependence on temperature in such systems is much more pronounced than in those where hydrogen-bonding is not present, as the following typical results show :

Absorbing molecule	λ(mμ)	*T*° C.	*D* (1 cm.)
Methanol	220	3	0·136
Methanol	220	25	0·253
Hexane	220	3	0·120
Hexane	220	25	0·140
Carbon tetrachloride	260	3	0·76
Carbon tetrachloride	260	25	0·92

We consider that the effect of temperature on the reported spectra can be interpreted in terms of the degree of hydrogen-bonding present. The presence of such bonds may lower the transition probability of the optical electrons.

M. Ito[9] has discussed a similar effect in the spectra of organic molecules.

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[1] Tsukamoto, *Rev. d'Optique*, **7**, 89 (1928).
[2] Kohler, *General Electric Review*, **39**, 232 (1936).
[3] Goodeve and Stein, *Trans. Farad. Soc.*, **27**, 393 (1931).
[4] Klevens and Platt, *J. Amer. Chem. Soc.*, **69**, 3055 (1947).
[5] Pearse and Gaydon, "The Identification of Molecular Spectra".
[6] Golding, *Nature*, **186**, 308 (1960).
[7] Urey, *J. Chem. Soc.*, 562 (1947).
[8] Barrett and Baxendale, *Trans. Farad. Soc.*, **56**, 37 (1960).
[9] Ito, *J. Mol. Spec.*, **4**, 106 (1960).

Drs. Barrett and Mansell imply that the ultraviolet absorption spectra of water reported by me[1] were due to failure to flush the optical path by oxygen-free nitrogen.

The normal spectrophotometric precautions for work in this difficult region were observed. The sample space and detector optics of the Beckman *DK2* were scavenged with dry oxygen-free nitrogen. The monochromator of the instrument involves only one beam path, and the double-beam chopping is external to this unit. This monochromator is factory-sealed, and was not flushed with nitrogen. The effects of stray light, scattered light and band-width were investigated.

Stray light (inherent in the instrument) and scattered light (inherent in the solvent) may be ignored (less than 1 per cent) below the following readings of optical density :

Wave-length	186 mμ	188 mμ	190 mμ	195 mμ
Maximum optical density for error < 1 per cent	0·5	0·6	1·2	2·0

The band-width can be kept to less than 0·3 mμ down to 185 mμ. By partially closing the sample shutter (equivalent to a fixed absorption), the deviation at the extreme end of the instrument from the fixed optical density reading can give a measure of the stray light figures, which are very dependent on the slit-widths as shown at 185 mμ.

Band-width	0·35 mμ	0·42 mμ	0·52 mμ	0·7 mμ
Percentage stray light	1	6	14	30

Flushing the instrument with dry nitrogen and bubbling nitrogen or hydrogen through the water sample for 12 hr. made no visible alterations to the spectrum. Reversing the sample and reference cells produced an exact mirror image of the spectrum. The spectrum did not come from the matched cells, since heating the reference cell to about 70° C. also had no effect on the spectrum. These precautions show that the water spectrum was real and not inherent in the Beckman *DK2* or in the various gases in the water and the instrument.

The water spectrum was shown to obey Beer's law by varying the path-length using a number of cells.

Path-length (cm.)	Optical densities		
	188·0 mμ	189·5 mμ	191·0 mμ
1	0·260	0·230	1·180
2	0·520	0·460	0·360
3	—	0·690	0·540

Concentrated sulphuric acid has no peaks in this region, and on adding water to the acid the water peaks suddenly appear.

In an experiment, two matched cells filled with water were placed in sample and reference beams, and the instrument gave a straight I_0 line. When solutes were added to the sample cell, the reported water spectrum[1] appeared, promoted by the presence of solute. This cannot be due to an instrument characteristic.

An extensive investigation of the Beckman *DK2* double-beam spectrophotometer suggests that the water spectrum at 190 mμ is real. A more detailed paper will be published shortly interpreting the results.

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[1] *Nature*, **186**, 308 (1960).

CRYSTALLOGRAPHY

Crystal Structure of 9 : 10-Dimethyl-1 : 2-benzanthracene

As part of an investigation into Daudel and Pullman's theory[1] of the connexion between the carcinogenic activity of benzanthracene derivatives and their structure, we have made an accurate determination of the crystal structure of 9 : 10-dimethyl-1 : 2-benzanthracene. It is a potent carcinogen, unlike its parent, 1 : 2-benzanthracene, the structure of which we have reported previously[2].

All X-ray data were collected from a good crystal, about 0·3 mm. on an edge, grown by cooling from amyl acetate. Basic data are : $a = 7{\cdot}62$ Å., $b = 8{\cdot}62$, $c = 21{\cdot}11$, space group $P2_1nb$, $Z = 4$ molecules/cell, $d_{calc.} = 1{\cdot}23$. (The alternative space group $Pmnb$ would lead to an impossibly high density unless all atoms lay in the planes $x = 1/4, 3/4$; this would cause the $0kl$, $2kl$, $4kl$, . . . reflexions to be essentially identical, and the $1kl$, $3kl$, $5kl$, . . . likewise. In fact these reflexions are similar but not identical.) Of the 1,647 independent reflexions observable with copper $K\alpha$ radiation, 347 were photometered from integrated Weissenberg photographs, 1,134 were estimated by eye from ordinary Weissenberg photographs, and the remaining 166, which were too weak to measure, were given intensities of half the minimum that could have been measured. No corrections for absorption were made.

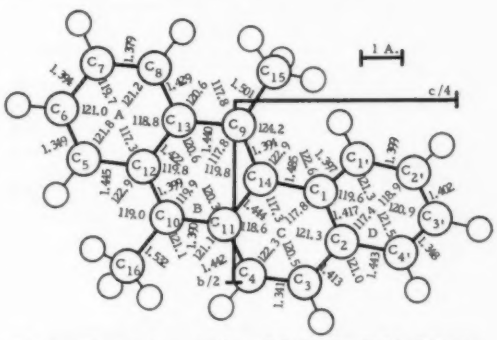

Fig. 1. The *a*-axis projection of 9 : 10-dimethyl-1 : 2-benzanthracene. The numbers give 3-dimensional bond-lengths and angles

The approximate structure was found from considerations of packing and by fitting a few critical reflexions. The refinement was done by least squares, using the programme *NY XR*1 on the *IBM* 704 to minimize the function $R' = \Sigma w_H(F_H^{obs.} - K'|F_H^{calc.}|)^2$. All 1,647 reflexions were included. The weights w_H were set equal to min. $(1, 100/F_H^{obs.2})$. The parameters refined were K', plus x, y, z, and B for each of the 20 carbon atoms. The hydrogen atoms were included, but were simply moved in conformity with the carbon skeleton. Table 1 and Fig. 1 show the results. The final values of the conventional discrepancy R and R' were 13·5 per cent and 1,261. The average standard deviations for atom position, C—C bond-length, C—C—C bond-angle, and temperature factor B are 0·008 Å., 0·011 Å., 1·2° and 0·14 Å.^{2}.

If the bond-lengths of the 23 C—C bonds are converted into bond orders by the use of Pauling's curve, it is found that they range from order 1·01, for the

Table 1. Final Parameters for 9:10-Dimethyl-1:2-benzanthracene

	Co-ordinates (fractional)			Co-ordinates (Å.)			
	x	y	z	x	y	z	B
C_1	0·2479	0·2522	0·0977	1·889	2·174	2·063	4·08
C_2	0·3266	0·3897	0·1212	2·488	3·360	2·558	4·73
C_3	0·4034	0·4995	0·0799	3·074	4·305	1·687	5·53
C_4	0·3959	0·4796	0·0170	3·017	4·135	0·358	5·04
C_5	0·2436	0·1595	−0·1706	1·856	1·375	−3·600	5·98
C_6	0·1909	0·0225	−0·1949	1·455	0·194	−4·115	6·79
C_7	0·1579	−0·1046	−0·1558	1·203	−0·901	−3·289	6·62
C_8	0·1842	−0·0919	−0·0914	1·403	−0·792	−1·929	5·11
C_9	0·2447	0·0676	0·0046	1·865	0·583	0·098	3·69
C_{10}	0·3222	0·3223	−0·0769	2·455	2·779	−1·623	4·35
C_{11}	0·3279	0·3400	−0·0115	2·498	2·931	−0·242	4·01
C_{12}	0·2660	0·1819	−0·1032	2·027	1·568	−2·179	4·37
C_{13}	0·2332	0·0524	−0·0632	1·777	0·452	−1·333	3·86
C_{14}	0·2708	0·2156	0·0295	2·064	1·859	0·623	3·54
C_{15}	0·2436	−0·0783	0·0435	1·856	−0·675	0·918	4·68
C_{16}	0·3745	0·4553	−0·1212	2·854	3·925	−2·559	6·61
C_1'	0·1444	0·1618	0·1380	1·101	1·394	2·913	4·53
C_2'	0·1275	0·1977	0·2023	0·971	1·704	4·272	6·09
C_3'	0·2175	0·3266	0·2265	1·657	2·816	4·782	6·70
C_4'	0·3093	0·4213	0·1880	2·357	3·632	3·969	6·08

C_{10}—C_{16} bond, to 1·90 for the C_3–C_4 (K region) bond. (The average bond order is 1·39, agreeing with the fact that after allowing for the C—H bonds there are 32 pairs of valence electrons to be distributed over the 23 C—C bonds, an average of 1·39 pairs per bond.)

The molecule is not planar. Ring D has been bent down out of the general plane by about 20°, and atom C_{16} up by about 12°. This distortion permits atoms C_{15} and C_1' to get 2·972 Å. away from each other.

We are grateful to Dr. Hugh Creech of the Institute for Cancer Research, Fox Chase, Philadelphia, for supplying a small amount of pure material, and to the U.S. Public Health Service and the International Business Machines Corporation for financial grants.

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[1] Daudel, R., and Pullman, A., *C.R. Acad. Sci., Paris*, **221**, 201 (1945).

[2] Friedlander, P. H., and Sayre, D., *Nature*, **178**, 999 (1956).

Crystal Structures of the High-Pressure Forms of Ice: Ice III

At the suggestion of Prof. Linus Pauling, we have undertaken a structural study of the high-pressure polymorphs of ice. Besides their intrinsic interest, bearing upon the relative stability of different crystalline arrangements under varying conditions of temperature and pressure, the results of this work will be pertinent, it is expected, to the structure of liquid water and to the energetics of the hydrogen bond.

In addition to the forms stable at atmospheric pressure (ice I, hexagonal, and ice Ic, cubic), six ice polymorphs (ice II–VII) stable at pressures upwards of 2,000 atmospheres are known; they were discovered by Tammann[1] and Bridgman[2]. An X-ray investigation by McFarlan[3] gave powder diffraction data for ice II and ice III, and led to structures for these two forms. No other data have hitherto been available. The structures given by McFarlan for ice II and ice III strongly violate the expected tetrahedral character of hydrogen-bonding by the water molecules, which led McFarlan to the conclusion that in these substances the water molecules are dissociated, their tetrahedral character is lost, and the protons lie midway between the oxygen ions. These conclusions are not in harmony with modern ideas on the nature of molecular structure and of intermolecular forces.

We have built equipment for making the high-pressure ice polymorphs and extracting them for X-ray study, utilizing Tammann's discovery that these substances can be held metastably at atmospheric pressure if maintained at liquid-nitrogen temperature. A small sample of water is confined in a cylindrical chamber closed by movable pistons and loaded by means of a hydraulic press. The temperature and pressure of the sample and its volume can be measured, and the phase transitions observed directly as discrete changes in volume. The press can then be submerged in liquid nitrogen, and the sample expelled, by means of the hydraulic press, into a liquid-nitrogen bath.

From samples prepared in this way we have obtained both X-ray powder diffraction and single-crystal data. The samples under X-ray examination were cooled continuously in a stream of nitrogen gas at − 190° C.

Our powder data for ice II and ice III disagree with McFarlan's data for the same substances. Our data for ice III are in fairly good agreement with McFarlan's data for ice II, for the larger spacings, whereas our data for ice II correspond to neither of McFarlan's sets of powder data. Because of these disagreements, we have checked carefully the identification of our ice II and ice III samples. They satisfy all the conditions of formation, stability and metastability given by Tammann and Bridgman (with the exception of the fact that our ice II does not, in experiments to date, transform rapidly to ice V on rising temperature). We have so far found no polymorph giving powder data in agreement with McFarlan's data for ice II.

Single-crystal data for ice III show that this polymorph is dimensionally cubic but symmetrically tetragonal, with $a \simeq c = 6{\cdot}80$ Å. The space group is $P\,4_12_12$. The density calculated on the basis of 12 molecules in the unit cell is $1{\cdot}14_1$ gm.cm.$^{-3}$, in satisfactory agreement with the value $1{\cdot}13_6$ gm.cm.$^{-3}$ obtained by extrapolating to zero pressure the ice III density values determined by Bridgman over the range 2,000–3,500 atmospheres, and correcting for thermal contraction by assuming that the average thermal expansion coefficient of ice III is the same as that of ice I over the temperature-range − 20° to − 190° C. Consistent with the space group and density, no other number of molecules in the cell is possible.

On rotation and precession photographs, the intensities of 45 separate reflexions have been measured, in the region $\sin\theta/\lambda < 0{\cdot}5$ Å.$^{-1}$. In addition, 13 intensities on rotation photographs correspond to superimposed pairs of reflexions, the separate intensities of which cannot be assigned without upper-level precession data not at present available. 61 additional reflexions in the region $\sin\theta/\lambda < 0{\cdot}5$ Å.$^{-1}$ have intensities too faint to observe.

It is possible to build a reasonable structure for ice III by placing 8 oxygen atoms in general positions and 4 oxygen atoms in special positions, as follows:

8 O_I in 8a: x, y, z; . . . ; with $x_I = 0{\cdot}095$, $y_I = 0{\cdot}30$, $z_I = 0{\cdot}29$

4 O_{II} in 4b: $x, x, 0$; . . . ; with $x_{II} = 0{\cdot}392$

The x and y parameters were also derived independently from the $hk0$ Patterson projection (13 independent reflexions only), and refined roughly by means of the (001) Fourier projection. Without systematic refinement of the parameters on the basis of the three-dimensional data, the overall agreement of calculated and observed intensities is good enough to indicate that the structure is correct. The residual $R = \Sigma|\sqrt{|F_o|^2} - \sqrt{|F_c|^2}|/\Sigma\sqrt{|F_o|^2}$ is 0·26 for the 45 observed reflexions. The calculated intensities of 13 reflexions chosen at random from among those unobserved are all weaker than the limit of observation.

In the ice III structure, each oxygen atom is surrounded by four others at distances of 2·73–2·90 Å., and the co-ordination polyhedra are approximately tetrahedral. The O_I oxygen atoms form four-fold spirals parallel to the c-axis. These spirals are linked together by the O_{II} atoms, each of which forms bonds to O_I atoms in four separate spirals. The arrangement is satisfactorily interpreted in terms of hydrogen-bonding, and the tetrahedral character of the water molecule is approximately retained, no hydrogen bond deviating by more than 15° from a tetrahedral direction.

The arrangement of oxygen atoms in ice III is very similar to that of the silicon atoms in silica K (keatite), a recently discovered[4] high-pressure polymorph of SiO_2. It is interesting, and certainly not unexpected, that the structural relationship between the silica and ice polymorphs, already known for ice I—tridymite and ice Ic—cristobalite, should be found to extend to the high-pressure forms. The tendency for the Si–O–Si bond angle in the silica polymorphs to be about 140° should, however, lead to a destabilization of the corresponding ice polymorphs, in which the hydrogen bonds would be correspondingly bent.

This work has been supported by the National Science Foundation. The detailed experimental methods and results will be published elsewhere.

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[1] Tammann, G., *Ann. d. Phys.*, **2**, 1 (1900).
[2] Bridgman, P. W., *Proc. Amer. Acad.*, **47**, 441 (1912); *J. Chem. Phys.*, **3**, 597 (1935); **5**, 964 (1937).
[3] McFarlan, R. L., *J. Chem. Phys.*, **4**, 60 and 253 (1936).
[4] Keat, P. P., *Science*, **120**, 328 (1954). Shropshire, J., Keat, P. P. and Vaughan, P. A., *Z. Krist.*, **112**, 409 (1959).

CHEMISTRY

Excited Electronic States of Lithium and Sodium Molecules

The electronic spectra of the alkali metal molecules are of interest for several reasons: for example, (1) Li_2 is sufficiently simple to be the subject of quantitative wave-mechanical calculations[1,2], and (2) these spectra may be expected to be somewhat similar to that of H_2, for which reliable analyses of many systems are now available[3,4]. Furthermore, the excited singlet *ungerade* states of the alkali metals are readily accessible, since they may be observed in combination with the ground states at $\lambda > 2300$ Å. It is therefore surprising that for Li_2 and Na_2 only the lowest excited singlet states, $A\ ^1\Sigma^+_u$ and $B\ ^1\Pi_u$, have been well characterized[5]: several systems at shorter wave-lengths have been reported[5,6], but the vibrational analyses of some of these are uncertain, and only for the system C—X of Na_2 has a rotational analysis been attempted[7].

We have now examined the C—X systems of Li_2 and Na_2, using photographs taken in absorption in first and third orders respectively of a 6·5 m. grating spectrograph. Previous vibrational analyses are confirmed, but rotational analysis of some twenty bands of each system shows that the upper states of both systems are in fact both $^1\Pi$, and presumably, since the C—X systems appear to be quite strong, $^1\Pi_u$. The earlier rotational analysis[7], which led to the conclusion that $C(Na_2)$ was $^1\Sigma^+_u$, is incorrect.

At wave-lengths shorter than the C—X systems, there are many further bands, and rotational analyses of several of these have also been made. A long $v' = 0$ progression established the vibrational numbering in the D—X system of Na_2: this again proves to be $^1\Pi_u - {}^1\Sigma^+_g$. In Li_2, the D—X system is also $^1\Pi_u - {}^1\Sigma^+_g$, but it has not yet proved possible to determine an unambiguous vibrational numbering for this system. The present results are summarized in Table 1.

Table 1

	State	T_e	ω_e	$x_e\omega_e$	B_e	$10^3\ \alpha_e$
$^7Li_2$	$D\ ^1\Pi_u$	< 34,140	~ 205	—	0·465	—
	$C\ ^1\Pi_u$	30,549	237·9	3·33*	0·5075$_4$	9·6$_4$†
Na_2	$D\ ^1\Pi_u$	33,440	110	0·5	0·1185	1
	$C\ ^1\Pi_u$	29,393	117·3	0·5$_3$	0·1281$_2$	0·8$_4$

* $+ 0·060\ (v + \frac{1}{2})^3$
† $+ 0·00013_4\ (v + \frac{1}{2})^3$

The energies of dissociation of these states are of considerable interest, and in the case of the C states of Li_2 and Na_2, quite definite lower limits can be given. Considering first Li_2, the state $B\ ^1\Pi_u$ is known to correlate with Li(2s) + Li(2p), so that the lowest excited atom pair to give $C^1\Pi_u$ is Li(2p) + Li(2p), with $E_A = 29{,}808$ cm.$^{-1}$. Taking[8] $D_e''(Li_2) = 9{,}185$ cm.$^{-1}$, $D_e'(C) \geqslant 8{,}445$ cm.$^{-1}$. By analogy, however, with the absorption spectrum of H_2, it might be expected that the strong absorption systems of Li_2 would be $(2s\sigma_g np\pi_u)\ ^1\Pi - {}^1\Sigma^+_g$, so that it is perhaps more probable that state C correlates with Li(2s) + Li(3p), with $E_A = 30{,}925$ cm.$^{-1}$. If this is so, $D'_e(C) = 9{,}560$ cm.$^{-1}$. In either case, the energy of dissociation in state C is not very different from that in the ground state.

For $C\ ^1\Pi$ in Na_2, the lowest possible atomic states are Na(3s) + Na(3d), with $E_A = 29{,}173$ cm.$^{-1}$. Thence, with[8] $D_e''(Na_2) = 6{,}215$ cm.$^{-1}$, $D'(C) \geqslant 5{,}995$ cm.$^{-1}$. However, it seems more probable that what is observed here is $4\ p\pi_u - 3s\sigma_g$ rather than the partly forbidden transaction $3d\pi_u - 3s\sigma_g$. In the former case, $E_A = 30{,}270$ cm.$^{-1}$, and $D'(C) = 7{,}090$ cm.$^{-1}$.

It is more difficult to reach a definite conclusion about the $D\ ^1\Pi_u$ state of Na_2. Bands may readily be followed up to $v' = 13$ at about 34,840 cm.$^{-1}$ above the minimum in the ground-state, but this is not high enough to rule out the possibility that $C^1\Pi_u$ is $(3s\sigma_g + 3d\pi_u)$ and that D is $(3s\sigma_g + 4p\pi_u)$. If, however, it is accepted that the correlation for state C is $(3s\sigma_g + 4p\pi_u)$, then state D may be correlated with $(3s\sigma_g + 5p\pi_u)$, to give $D'(D) = 7{,}815$ cm.$^{-1}$. In this case, states B, C, D form a Rydberg series of states $(3s\sigma_g np\pi_u)^1\Pi_u$, and we may obtain an approximate value for the ionization potential of Na_2 as follows:

State	T_e	m	Initial potential
B	20,320	2·325	40,610
C	29,393	3·325	39,313
D	33,440	4·325	39,300

Thus the ionization potential (Na_2) $\sim$ 39,300 cm.$^{-1}$. Since the ionization potential (Na) = 41,450 cm.$^{-1}$, this implies that $D(Na_2^+)$ is greater than $D(Na_2)$ by about 2,150 cm.$^{-1}$ or 35 per cent. At first sight, this is a very surprising conclusion, but, as Prof. Coulson has pointed out to us, theoretical calculations[9] indicate that Li_2^+ is more stable than Li_2 by about 1,200 cm.$^{-1}$.

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[1] James, *J. Chem. Phys.*, **2**, 794 (1934).
[2] Aral and Sakamoto, *J. Chem. Phys.*, **28**, 32 (1958).
[3] Dieke, *J. Mol. Spectroscopy*, **2**, 494 (1958).
[4] Herzberg and Howe, *Canad. J. Phys.*, **37**, 636 (1959).
[5] Herzberg, "Molecular Spectra and Molecular Structure, I. Spectra of Diatomic Molecules" (New York, 1950).
[6] "Données Spectroscopiques concernant les Molécules diatomiques", edit. by Rosen (Paris, 1951).
[7] Sinha, *Ind. J. Phys.*, **22**, 401 (1948).
[8] Evans, Jacobson, Munson and Wagman, *J. Res. Nat. Bur. Stand.*, **55**, 83 (1955).
[9] James, *J. Chem. Phys.*, **3**, 9 (1935).

Infra-Red Frequency Shifts

The effect of liquefaction and solution in different solvents on infra-red group frequencies has previously been considered in terms of changes in dielectric constant and postulated local association effects (for example, Caldow and Thompson[1], and Bellamy and Williams[2]). A more fundamental approach would seem to be to relate the shifts to the actual solute-solution interaction energy.

At infinite dilution the solute-solution interaction energy is given very approximately by:

$$E_{1S} = E_{12} = \frac{1}{2}\left[L_1 + \left(\frac{V_1}{V_2}\right)^n L_2 - \Delta\bar{E}_1\right] \qquad (1)$$

where L_1, L_2 and V_1, V_2 are the internal latent heats and molal volumes of solute and solvent respectively, and $\Delta\bar{E}_1$ is the partial molal heat of mixing at infinite dilution. The value of n varies with the solvent, but in the absence of data will be taken to be $\frac{2}{3}$ (this amounts to the assumption that the energy required to form a hole is proportional to its surface area).

Fig. 1 is a plot of E_{1S} against the fractional frequency shift, $\frac{\Delta\nu}{\nu}$, of the carbonyl group in acetone in solution in various solvents as reported by Bellamy and Williams[2]. The values of $\Delta\bar{E}_1$ were obtained from the International Critical Tables[4] except those for acetonitrile and nitromethane which were calculated from the data of Brown and Fock[5] at 45° C. assuming no change with temperature (this may be a poor approximation). Evidently to a fair approximation:

$$\frac{\Delta\nu}{\nu} = \frac{E_{1S}}{K} \qquad (2)$$

where K is a constant equal to $5{\cdot}4 \times 10^5$ cal./mole for acetone. Because of lack of data it has not been possible to demonstrate the validity of equation 2 for solutes other than acetone; but if the relation is generally true the frequency shifts for different groups in the same molecule should be rectilinearly related.

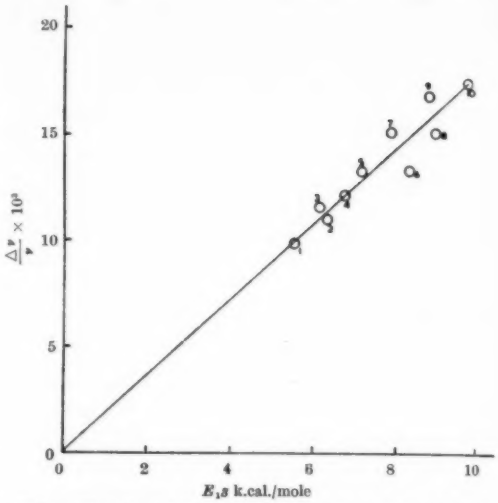

Fig. 1. Variation of frequency shift of acetone carbonyl group in different solvents with solute-solution interaction-energy. The solvents are: 1, ether; 2, carbon tetrachloride; 3, carbon disulphide; 4, benzene; 5, acetone; 6, acetonitrile; 7, chloroform; 8, nitromethane; 9, ethanol; 10, methanol

Such a relationship has been shown to exist for a number of molecules (for example, Bellamy, ref. 6).

It is evident from consideration of the frequency shifts on liquefaction that the value of K is different even for the same group in different molecules; this is presumably connected with the way in which the interaction energy is distributed among the degrees of freedom as well as with differences between the force constants of the bonds.

If equation 2 is found to be generally valid, the much-discussed question of what proportion of the frequency shift is attributable to non-specific interactions can be considered in terms of the extent to which pure dispersion energy contributes to the latent heats and heat of mixing.

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[1] Caldow, G. L., and Thompson, H. W., *Proc. Roy. Soc.*, A, **254**, 1 (1960).
[2] Bellamy, L. J., and Williams, R. L., *Proc. Roy. Soc.*, A, **255**, 22 (1960).
[3] Bellamy, L. J., and Williams, R. L., *Trans. Farad. Soc.*, **55**, 14 (1959).
[4] "International Critical Tables" (McGraw-Hill, New York, 1929).
[5] Brown, I., and Fock, W., *Austral. J. Chem.*, **10**, 417 (1957).
[6] Bellamy, L. J., "The Infra-red Spectra of Complex Molecules", second ed., 404 (Methuen, London, 1958).

Two Highly Selective Solvents for Gas-Liquid Chromatography Analysis of C_2–C_4 Hydrocarbons

In the course of a systematic investigation of polar stationary liquids for gas-liquid chromatography at a column temperature of 30° C., it was found that dimethyl sulphoxide (CH_3SOCH_3, b.p. 189° C.) and sulpholane (tetramethylene sulphone, $(CH_2)_4SO_2$, b.p. 284° C.) are very suitable for the analysis of complex C_2–C_4 hydrocarbon mixtures. Under the conditions used (see below), columns charged with

firebrick impregnated with these solvents have the following properties :

(1) Compounds of closely similar boiling point but different molecular type show widely different retention volumes. Relative corrected retention volumes (*n*-paraffin = 1·00) for (hypothetical) compounds with b.p. 30° C. are given in Table 1. For comparison data on the solvents dimethylsulpholane and squalane have been included, and retention volumes for one type of chlorinated compound are given.

Table 1. RELATIVE CORRECTED RETENTION VOLUMES FOR COMPOUNDS WITH b.p. 30° C.

Homologous series of compounds	Solvent			
	Dimethyl-sulphoxide	Sulpholane	Dimethyl-sulpholane	Squalane
2,2-Di-me-alkanes	0·8	0·86	0·81	0·96
2-me-alkanes	0·9	0·95	0·89	1·00
n-Alkanes	(1·00)	(1·00)	(1·00)	(1·00)
1-Alkenes	2·0	2·1	1·7	1·00
trans-2-Alkenes	2·2	2·1	1·8	1·00
2-me-1-Alkenes	2·45	2·4	1·9	1·00
cis-2-Alkenes	2·5	2·5	1·9	1·00
Unbranched *cyclo*alkenes	2·5	2·4	1·9	1·3
1,2-Alkadienes	6·5	5·9	3·7	1·00
1-Cl-alkanes	11·0	11·7	6·4	0·77
1-Alkynes	15·3	11·7	6·4	0·69

(2) The separation efficiency is high. In the range of relative corrected retention volumes (*n*-butane = 1·00) up to 10·0, the average height equivalent to a theoretical plate is 1·5 mm. for dimethyl sulphoxide and 1·7 mm. for sulpholane (sample size of gaseous component < 0·1 ml.).

As a result of these two properties, the following compounds having closely similar boiling points are completely separated : ethane–ethylene–nitrous oxide–carbon dioxide–acetylene, and *iso*butene–1-butene. The resolution of 2-methyl-pentane (b.p. 60·3° C.) and 2,3-dimethylbutane (b.p. 58·0° C.) is nearly complete and comparable to that achieved by *iso*quinoline[1].

(3) Owing to the low solubility of paraffins and olefins, the time of analysis is short. Complex mixtures of hydrocarbon gases up to and including *cis*-2-butene can be analysed in 25 min. A complete separation of the 13 paraffins from methane to *n*-hexane is effected in 35 min.

(4) The solvents do not react with unsaturated compounds. When acetylenic compounds with active hydrogen atoms are determined, however, glass or stainless steel tubing is required as they react with copper in the presence of dimethyl sulphoxide. For sulpholane, copper tubing can be used.

(5) The volatility of dimethyl sulphoxide is not negligible, which causes retentions to decrease gradually. From the vapour pressure at 30·0° C.[2] it is calculated (for conditions specified below) that about 1,000 l. of carrier gas are required to make the loss of weight exceed the still allowable value of 5 per cent. As the liquid phase is mainly stripped off in the first section of the column, a regular replacement of this section will dispose of this problem. The operating conditions were :

	Dimethyl sulphoxide	Sulpholane
Column length	14·4 m.	18·0 m.
Internal diameter	6 mm.	
Packing	C-22 firebrick, 50/80 mesh	
Weight ratio solvent/solid support	30 : 70	
Hydrogen flow-rate	5·0 l./hr.	4·0 l./hr.
Column temperature (air bath)	30·0° ± 0·1° C.	

The commercial solvents were distilled before use ; the colourless products had the following properties :

	Dimethyl sulphoxide	Sulpholane
Boiling point	61° C. at 6 mm. mercury	168·5° C. at 31 mm. mercury
Melting point	18° C.	27° C.
n_D 30·00	1·47475	1·48168
Density (gm./ml.) at 30·00° C.	1·09036	1·26120

Thanks are due to Dr. G. W. A. Rijnders for his interest in this investigation and to Messrs. J. D. Kommer, H. J. Bogaard and N. v.d. Hoed for their co-operation in the experimental work.

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[1] Zlatkis, A., *Anal. Chem.*, **30**, 332 (1958).
[2] Douglas, T. B., *J. Amer. Chem. Soc.*, **70**, 2001 (1948).

Gas-Solid Chromatographic Separation of Hydrocarbons of High Molecular Weight

THE deactivation of highly active polar sites[1] on activated alumina with water to give a satisfactory column packing for the gas chromatographic separation of C_1–C_5 hydrocarbons at room temperature has been reported[1]. An extension of this work has shown that alumina can be similarly deactivated with inorganic bases and salts added in aqueous solution, the water being removed by subsequent heat treatment. At low degrees of deactivation, retention volumes for aromatic hydrocarbons can be varied relative to aliphatic hydrocarbons according to the extent of deactivation. However, the amount of sample required (~100 μgm.) to obtain a response from a flame-ionization detector suggests that considerable irreversible adsorption takes place. The most promising application appears to be at the highest degrees of deactivation (lowest activity-levels, when irreversible adsorption is much reduced) for the separation of high-molecular weight hydrocarbons.

Fig. 1 shows the separation of C_{15}–C_{23} *n*-paraffins using an alumina (initial surface area 180 m.²/gm.) preheated for 70 hr. at 750° C. to reduce surface area and to which was added 40 per cent by weight of sodium hydroxide.

Fig. 2 shows the separation of C_{26}–C_{36} *n*-paraffins on the same column with the temperature ranging

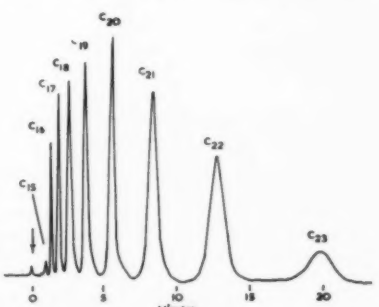

Fig. 1. Separation of refined paraffin wax. Column packing, 100 parts by weight alumina + 40 parts by weight sodium hydroxide ; column dimensions, 3 ft. × ¼ in. outside diameter ; column temperature, 250° C. ; sample size. ~ 10 μgm. ; detector, flame ionization ; carrier gas, 75/25 hydrogen/nitrogen (50 ml./min.)

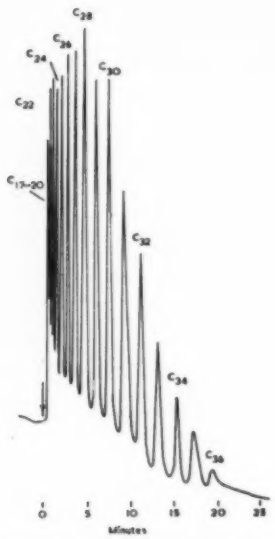

Fig. 2. Separation of refined paraffin wax. Detail as Fig. 1, but column temperature ranging from 320° to 390° C.

from 320° to 390° C. over a period of 20 min. The base-line drift is a function of the detector with change in operating temperature.

Eglinton *et al.*[2] have shown that the use of a sensitive detector permits the chromatography of high molecular weight compounds at reduced operating temperatures; for example, $C_{36}H_{74}$ at 228° C. With gas-liquid columns, extension of this principle to higher molecular weight compounds is limited by response of the detector to carry-over of liquid phase and/or its decomposition products. Such limitation does not exist with alumina modified with an inorganic compound such as sodium hydroxide. The present investigation is aimed at reduction in retention volumes by further reduction in activity of the final modified material, so that the combination of high sensitivity of detector and high temperature of operation can be utilized for rapid separation of *n*-paraffins greater than C_{50}.

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[1] Scott, C. G., *J. Inst. Pet.*, **45**, 118 (1959).
[2] Eglinton, G., Hamilton, R. J., Hodges, R., and Raphael, R. A., *Chem. and Indust.*, 955 (1959).

Microanalytical Separation of Steroids by Gas Chromatography

The application of gas-liquid partition chromatography to the microanalytical separation of steroids has been recognized for some time as an attainable goal. The chief barrier to practical advances in the problem arises from the nature of the thermostable liquid phases that are now known and the properties of steroids. 'Apiezon' greases, thermostable silicones and polybutenes may be used at relatively high temperatures; but the distribution coefficients for many steroids are much in favour of these phases even at elevated temperatures[1].

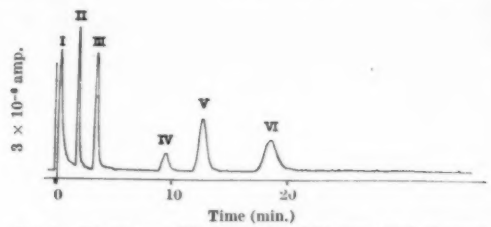

Fig. 1. Chromatographic separation of 50 μgm. total of steroid sample, as 5 per cent solution in benzene. Column temperature, 270°; argon pressure, 25 p.s.i.; column size, 100 cm. × 2 mm.; argon ionization detection system. Compounds are I, solvent and androstane; II, androstan-17-one; III, cholesterol methyl ether and cholestanol methyl ether; IV, cholestanone; V, androstan-3,17-dione; VI, Δ^4-androstene-3,17-dione

An alternative to the use of non-polar phases lies in exploring the separating properties and retention times for thermostable polar phases. We have worked with an ethylene glycol–*iso*phthalic acid polyester (E. I. du Pont de Nemours, Inc.). The column packing was prepared by a solution technique[2] with a 10 per cent chloroform solution of the polyester and 60–80 mesh acid-washed 'Celite 545'. The coated 'Celite', containing 20 per cent (w/w) of stationary phase, was vibration-packed in a glass U-column (100 cm. × 2 mm.) and was conditioned briefly at 200°. A Lovelock argon ionization detector was used.

The separation of a synthetic mixture of steroids is shown in Fig. 1. Analyses within a temperature-range of 220–280°, with argon flow-rates of 50–100 ml./min., showed column efficiencies of 1,400–1,800 theoretical plates. No separation was observed for cholesterol methyl ether and cholestanol methyl ether in any circumstances, but androstane-3,17-dione and Δ^4-androstene-3,17-dione had widely different retention times. There was no evidence of decomposition of any of these compounds; but this point must be studied in greater detail and particularly with respect to derivatives of hydroxyl-substituted compounds. The thermal stability of the column was relatively good; there was almost no 'bleed' at 200–220°, and thermal breakdown required several days at 280°.

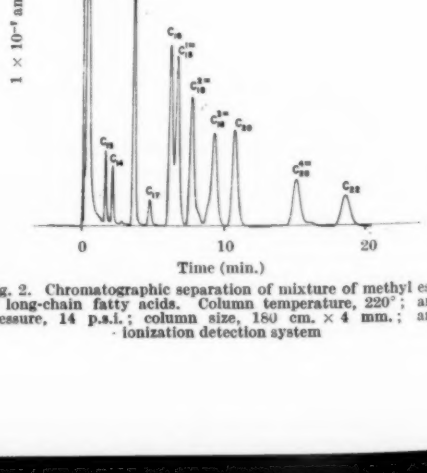

Fig. 2. Chromatographic separation of mixture of methyl esters of long-chain fatty acids. Column temperature, 220°; argon pressure, 14 p.s.i.; column size, 180 cm. × 4 mm.; argon ionization detection system

Present knowledge of the properties of polyester phases is largely based on their use in lipid work for the separation of fatty acid methyl esters; this use is based on the observations of Lipsky and Landowne[3], Orr and Callen[4] and Craig and Murty[5]. Fig. 2 shows an array of fatty acid esters separated on an ethylene glycol–*iso*phthalate polyester column. The column may be useful for examinations of mixtures of very long chain compounds since the C–24 level may be reached in a few minutes if desired, but it is not likely to be useful in quantitative work because of the failure to separate completely methyl stearate and methyl oleate (oleate/stearate separation factor = 1·07).

For steroid separations, as with fatty acid esters, it is likely that both non-polar and polar phases will find specific applications. The present investigation provides an example of a polar phase suitable for steroid work.

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[1] This effect is reflected in the data of Eglinton, G., Hamilton, R. J., Hodges, R., and Raphael, R. A., *Chem. and Indust.*, 955 (1959); the retention time for cholestanone in a 46-in. column at 220° with an 'Apiezon' *L*-phase was just under 4 hr. Other laboratories have observed shorter retention times under different circumstances (Lipsky, S. R., private communication).
[2] Horning, E. C., Moscatelli, E. A., and Sweeley, C. C., *Chem. and Indust.*, 751 (1959).
[3] Lipsky, S. R., and Landowne, R. A., *Biochim. Biophys. Acta*, **27**, 666 (1958). Lipsky, S. R., Landowne, R. A., and Godet, M., *ibid.*, **31**, 356 (1959).
[4] Orr, C. H., and Callen, J. E., *J. Amer. Chem. Soc.*, **80**, 249 (1958).
[5] Craig, B. M., and Murty, N. L., *Canad. J. Chem.*, **36**, 1297 (1958).

Analysis of Solubility Data to estimate Small Amounts of Chain Fracture during the Cross-linking of Rubber

In a communication[1] on methods of estimating chain fracture during the cross-linking of rubber by high-energy radiation, we mentioned that a quantitative analysis of solubility data was not attempted because results did not conform with a theoretical relationship derived by Charlesby and Pinner[2]. This relates the sol fraction (S) after dose R with the fracture and cross-link densities (p and q, respectively) and includes as a parameter the number average degree of polymerization before irradiation (u). This relationship (1) applies only for a polymer with a random molecular weight distribution and for the case where fracture and cross-linking are random and proportional to the dose. Hayden[3] has recently reported results which apparently do conform with this relationship. These are now contrasted with our previous results in order to emphasize some limitations concerning the general utility of this method for estimating small ratios of fractures to cross-links.

$$S + S^{\frac{1}{2}} = pq^{-1} + (quR)^{-1} \qquad (1)$$

Most of our samples of rubber were taken from the same source as Hayden's and apparently only differed in having been initially masticated to lower molecular weight; they were also irradiated under similar conditions. The linear plot reported by Hayden and represented in Fig. 1 was defined by results obtained after doses of up to about 15 M.rads.

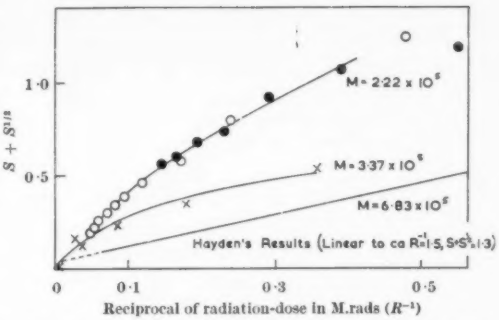

Fig. 1. Curves of $S + S^{1/2}$ against reciprocal dose for various rubbers irradiated with 4-MeV. electrons. Dose-rate of order 10^6 rads/min. M values represent initial number average molecular weight

It can be seen that in addition we obtained results at higher doses which do not lie on a straight line, but instead curve towards the horizontal axis. In these circumstances the significance of Hayden's linear extrapolation from his results to the $S + S^{\frac{1}{2}}$ axis and his estimation of the ratio of fracture to cross-links, pq^{-1}, as 0·05 is open to doubt.

The discrepancy between our results and simple theory is not surprising because it seems certain that such samples of rubber do not have a random molecular weight distribution[4]. This is, of course, generally the case for most samples of polymer, and it is significant that similar analysis of solubility data has usually been applied to estimate relatively high values of pq^{-1} of about 0·3. In such cases a random distribution might well be formed through random fracture during irradiation, and relationship (1) would then be applicable to solubility measurements made after sufficiently high doses. The average number of fractures per initial molecule may be calculated from the expression $6{\cdot}25 \times 10^{17}\, RG(F)MN^{-1}$, where $G(F)$ is the number of fractures for a dose of 100 eV., equal to 0·04 in Hayden's experiments, N the Avogadro number, and R and M are as defined previously. Then in the dose-range of from about 0·8 to 15 M.rads, in which he found a linear relationship between $S + S^{\frac{1}{2}}$ and R^{-1}, the corresponding average number of fractures per molecule would only be 0·02–0·43. This small amount of fracture would have relatively little effect on the molecular weight distribution[5] and therefore Hayden's rubber, unlike ours, either approximated to a random distribution before irradiation or his interpretation of the intercept obtained by linear extrapolation is unjustified. Current measurements indicate that the first of these alternatives is unlikely. For example, a rubber of number average molecular weight 5×10^5 had a ratio of weight to number average molecular weights closer to 1 rather than to the value of 2 characteristic of a random distribution (Allen, P. W., and Bristow, G. M., unpublished work).

In summary, we emphasize that in order to estimate small values of pq^{-1} from solubility measurements it is important to obtain data after sufficiently high doses and also to consider whether the assumption of a random molecular weight distribution is justified in order that relationship (1) may properly be applied.

Samples were irradiated at Wantage Radiation Laboratories (Atomic Energy Research Establishment) and we thank Dr. R. Roberts and members

of the Technological Irradiation Group for their kind co-operation.

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[1] Mullins, L., and Turner, D. T., *Nature*, **183**, 1547 (1959).
[2] Charlesby, A., and Pinner, S. H., *Proc. Roy. Soc.*, A, **249**, 367 (1959).
[3] Hayden, P., *Nature*, **184**, 1865 (1959).
[4] Angier, D. J., and Turner, D. T., *J. Polymer Sci.*, **28**, 265 (1958).
[5] See Bovey, F. A., "The Effects of Ionising Radiation on Natural and Synthetic High Polymers", 74 (1958).

Structure of β-Acylacrylic Acids

In previous publications[1–5] the β-formyl-, β-acetyl- and β-pivaloyl-acrylic acids were investigated by means of their spectra in the ultra-violet and infra-red. This work has been extended to comprise the α-methyl-β-acrylic acid[6,7]. In regard to *cis–trans* isomerism and open or cyclic structure for the preparations used, the infra-red spectra (in the case of acid (5) also by means of the nuclear magnetic resonance) have confirmed the following structures:

(1) β-Formylacrylic acid, m.p. 53–56° C.: cyclic, *cis*
(2) β-Acetylacrylic acid, m.p. 122–125° C.: *trans* (probably with a smaller amount *cis*-open acid)
(3) β-Pivaloylacrylic acid, m.p. 84–85° C.: cyclic, *cis*
(4) β-Pivaloylacrylic acid, m.p. 94–95° C.: *trans*
(5) α-Methyl-β-acetylacrylic acid, m.p. 98–101° C.: cyclic, *cis*

The ultra-violet spectra of compounds (1) and (3) had end-absorption, but (2) and (4) had a maximum at about 220 mμ (in water). The former had, however, more or less a shoulder at 240 mμ, which with increasing *p*H developed to a maximum at 245 mμ, which upon acidification disappeared. With development of the maximum at 245 mμ a maximum or a shoulder appeared at about 320 mμ, indicating a ketonic group. Thus, the ring in these cases should be opened by neutralization. Now, the compound (5) has shown the same behaviour.

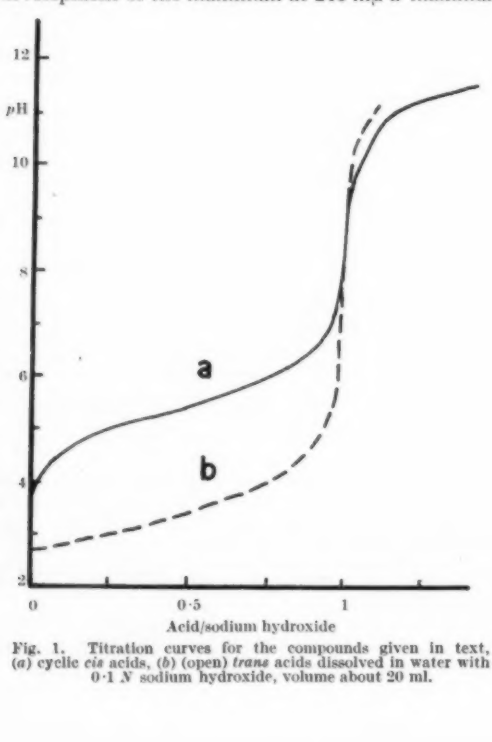

Fig. 1. Titration curves for the compounds given in text, (*a*) cyclic *cis* acids, (*b*) (open) *trans* acids dissolved in water with 0·1 *N* sodium hydroxide, volume about 20 ml.

Regarding the cyclic formula one could expect compounds with this structure to have acidic properties, and therefore it seemed worth while to compare these two categories by means of titrations and *p*H determinations. Fig. 1 gives in short the results; curve (*a*) refers to the cases (1), (3) and (5), that is, the cyclic *cis* structure, and curve (*b*) to the cases (2) and (4), that is, the (open) *trans* structure. Evidently, this seems to be a complementary method for determining the structure, and it follows that the pK_a values about 5·5 and 3·5 respectively characterize the curves. Back-titration gives the same curves. As from the ultra-violet spectra it must be concluded that the ring opens upon neutralization, it evidently is—if not instantaneously but very rapidly—closed upon acidification. Thus, it seems evident that the maximum at 245 mμ refers to the open *cis* form, which has been proposed previously.

A further report, also including nuclear magnetic spectra for these compounds, will be given elsewhere with a more detailed discussion.

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[1] Hellström, N., *Ann. Roy. Agric. Coll. Sweden*, **22**, 297 (1955).
[2] Hellström, N., *Nature*, **179**, 589 (1957).
[3] Hellström, E. N. E., *Ann. Roy. Agric. Coll. Sweden*, **23**, 519 (1957).
[4] Hellström, N., *Acta Agric. Scand.*, **8**, 285 (1958).
[5] Hellström, N., and Gronowitz, S., *Ann. Roy. Agric. Coll. Sweden*, **25**, 363 (1959).
[6] Jones, E. R. H., Shen, T. Y., and Whiting, M. C., *J. Chem. Soc.*, **48**, 763, 766 (1951).
[7] Buchta, E., and Satzinger, G., *Chem. Ber.*, **92**, 449, 468 (1959).

BIOCHEMISTRY

Occurrence of Keto-Acids in Blood Serum and Urine of Cattle in Comparison with Man, Horse, Sheep and Dog

In connexion with metabolic disorders occurring in cows, such as parturient paresis and acetonæmia, an investigation concerning the keto-acids occurring in blood serum and urine was started. Several authors have carried out work in this field concerning man. Keto-acids are converted into 2,4-dinitrophenylhydrazones, after which they are separated by means of paper chromatography. The 2,4-dinitrophenyl hydrazones are reduced by hydrogen to amino-acids and identified as such. In this way Cavallini *et al.*[1], El Hawary and Thompson[2], Markees[3], Biserte and Dassonville[4] and De Schepper *et al.*[5] showed that the following α-keto-acids occur in human blood: α-ketoglutaric acid, pyruvic acid, α-keto*iso*caproic acid, α-keto*iso*valeric acid and α-keto-β-methylvaleric acid. Moreover, it was shown that pyruvic acid predominates in human blood and α-ketoglutaric acid in human urine[4].

Applying De Schepper's method[5] the keto-acids of bovine serum were converted into 2,4-dinitrophenyl hydrazones and separated by means of chromatography, as well as by electrophoresis combined with evaporation at 6 V./cm. at *p*H 11·7. After reduction with hydrogen and platinum oxide as a catalyst, the amino-acids obtained were examined both by electro-

Table 1. A Comparison of the Keto-acids in Blood and Urine of Cattle, Sheep, Dog, Horse and Man

Blood	Cattle	Sheep	Dog	Horse	Man (own estimations)	Man (see ref. 5) (per cent)	Man (see ref. 4)
Oxaloacetic acid	0 − +	0 − +	−	0 − +	0 − +		0
α-Ketoglutaric acid	+ +	+ +	+ +	+ +	+ +	35–165γ	+
Glyoxylic acid	+ − + +	+	0 − +	+	0 − +		±
Pyruvic acid	+ + + +	+ + + +	+ + + +	+ + + +	+ + + +	380–900γ	+ +
Succinic semialdehyde	+ +	+ − + +	+	+ − + +	+ − + +		+(x)
α-Keto*iso*valeric acid	+	0 − +	+	0 − +	+	930–1,900γ	+ +
α-Keto*iso*caproic acid	+ +	+	+ +	+	+ +		
α-Keto-β-methylvaleric acid							
Urine							
Oxaloacetic acid	+	+	0 − +	0 − +	0 − + +		0
α-Ketoglutaric acid	+ +	+ +	+ +	+ + +	+ + + + +		+ + + +
Glyoxylic acid	+ + + +	+ + + +	+ + +	+ +	+		0
Pyruvic acid	0 − +	+	+ +	+ +	+ +		+ + +
Succinic semialdehyde	+ +	+ +	+	+	+		+(x_2)
α-Keto*iso*valeric acid	−	0 − +	0 − +	0 − +	0 − +		−
α-Keto*iso*caproic acid	0 − +	−	−	−	0 − +		−
α-Keto-β-methylvaleric acid							

phoresis at *p*H 4·7 and by two-dimensional chromatography in different solvents. The following amino-acids were formed: aspartic acid (in small quantities), glutamic acid, alanine (much), valine and *iso*-leucine, γ-aminobutyric acid and glycine. From this it follows that besides the keto-acids mentioned before, succinic semialdehyde and glyoxylic acid occur in bovine blood as well.

As succinic semialdehyde, so far as we know, has not hitherto been found to occur in human blood, and glyoxylic acid only occasionally[4], identical experiments were made with human serum. It appears that it contains succinic semialdehyde as well as glyoxylic acid. Bovine urine, after preliminary purification, was investigated in the same way. The most striking result was the high content of glyoxylic acid. Moreover, bovine urine contains oxaloacetic acid and succinic semialdehyde. As the observations made by Biserte[4] on human urine were different, the latter was examined in the same manner. It appeared that now α-ketoglutaric acid showed the highest value, followed by pyruvic acid and finally succinic semialdehyde, oxaloacetic acid and glyoxylic acid. These results are in accordance with Biserte's findings.

As there was this remarkable difference between the contents of glyoxylic acid in human and bovine urine, the serum and urine of a few other animals, namely, sheep, horse and dog, were examined. The results are shown in Table 1. The intensity of the spots, coloured by interaction with ninhydrin, of the amino-acids produced by reduction is indicated by the number of + signs.

From Table 1 it appears that the serum contents of keto-acids in man and in the various animals show only slight differences; the urine, however, varies considerably.

This investigation has shown that: (*a*) Human serum and urine contain succinic semialdehyde in addition to the α-keto-acids already found. Glyoxylic acid occurs in small quantities in human serum as well as in urine. (*b*) Serum of cow, sheep, horse and dog contains the same keto-acids as human serum, and in almost the same quantities. (*c*) Bovine and sheep urine contains, compared with human urine, a far greater quantity of glyoxylic acid, whereas the latter contains more α-ketoglutaric acid.

Details of the methods used will be published in full with the results of an investigation on the keto-acids in the rumen of cattle. I am greatly indebted to Miss W. Klazinga and Mr. H. Vreman and Mr. C. G. van der Kamp for experimental assistance and Mr. W. D. Brands for making the necessary equipment.

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[1] Cavallini, D., and Frontali, N., *Nature*, **164**, 792 (1949).
[2] El Hawary, M. F. S., and Thompson, R. H. S., *Biochem. J.*, **53**, 340 (1953).
[3] Markees, S., *Biochem. J.*, **56**, 703 (1954).
[4] Biserte, G., and Dassonville, B., *Clin. Chim. Acta*, **1**, 49 (1956).
[5] De Schepper, P., Parmentier, G., and Vanderhaeghe, H., *Biochim. Biophys. Acta*, **28**, 507 (1958).

Formation of a New Metabolite of Epinephrine and Norepinephrine in Liver and Kidney

In previous work it was found that after the injection of norepinephrine and epinephrine in rats, a new metabolite of these compounds was excreted in the urine[1]. Axelrod *et al.*[2] have isolated recently from the urine of rats a metabolite of epinephrine and norepinephrine, which they have identified as 3-methoxy-4-hydroxy phenyl glycol. We have found that after the intravenous infusion in cats of a mixture containing both norepinephrine-7-^{3}H and epinephrine-1-^{14}C, a similar compound was found in the liver and kidney of this animal.

In these experiments, 10 ml. of $4{\cdot}5 \times 10^{-6}$ *M* solution of norepinephrine-7-^{3}H and epinephrine-1-^{14}C with a ^{3}H : ^{14}C activity ratio of 5 : 1 were infused during a period of 30 min. into the femoral veins of untreated cats and cats pretreated with iproniazid phosphate. At the end of the infusion period the animals were killed and the organs were removed and quickly frozen. The tissues were homogenized in saline and then deproteinized by the addition of 0·4 *N* perchloric acid according to the procedure of Ake Bertler *et al.*[3]. The water layer at *p*H 2 was extracted four times with ethyl acetate. This ethyl acetate fraction was then chromatographed in chloroform–acetic acid–water (2 : 1 : 1) overnight. The run-off was then chromatographed in *iso*propyl alcohol–aqueous ammonia–water (8 : 1 : 1) over a period of 12 hr. In this procedure 3,4-dihydroxy-mandelic acid remained on the paper in the chloroform–acetic acid–water system and the run-off contained 3-methoxy-4-hydroxymandelic acid.

Table 1. Tritium and Carbon-14 Activity of 3-Methoxy-4-hydroxymandelic Acid and the Neutral Metabolite isolated from Liver and Kidney of a Cat infused with Norepinephrine-7-^{3}H and Epinephrine-1-^{14}C

Compound	Liver			Kidney		
	c.p.m. per 1 gm. tissue ^{3}H	^{14}C	^{3}H/^{14}C	c.p.m. per 1 gm. tissue ^{3}H	^{14}C	^{3}H/^{14}C
3-Methoxy-4-hydroxy-mandelic acid	810	270	3/1	1,200	360	3·3/1
Neutral metabolite	350	100	3·5/1	520	165	3·1/1

In cats untreated with iproniazid the final chromatogram developed from liver and kidney extracts showed in addition to the presence of 3-methoxy-4-hydroxymandelic acid another radioactive peak. The mobility of this peak was found to be greater than the mobility of 3-methoxy-4-hydroxymandelic acid. In cats treated with iproniazid, however, these peaks were not found.

The fast-moving peak was demonstrated to behave as a neutral compound since it was extractable into ethyl acetate from the aqueous phase in the *p*H range of 1–8. This compound was readily acetylated and from its mobility in the Bush '*C*' solvent system[4] it appeared to be a polar substance. The ^{3}H : ^{14}C ratio for 3-methoxy-4-hydroxymandelic acid was found to be the same as for the neutral compound (Table 1). This shows that the neutral compound is formed from norepinephrine and epinephrine in the same proportion as 3-methoxy-4-hydroxymandelic acid.

The chromatographic behaviour of the neutral compound that we have isolated was found to be similar to that of 3-methoxy-4-hydroxyphenyl glycol. In the butanol–alcohol–water system, the R_F value of this compound was identical with the R_F value of 3-methoxy-4-hydroxyphenyl glycol (Axelrod, J., private communication). 3-Methoxy-4-hydroxyphenylacetaldehyde was postulated by Axelrod[1] to be a common precursor for 3-methoxy-4-hydroxymandelic acid and 3-methoxy-4-hydroxyphenyl glycol. The fact that the same ratio of ^{3}H : ^{14}C was found for 3-methoxy-4-hydroxymandelic acid and the neutral compound indicates that both have a common precursor.

The finding that in cats treated with iproniazid 3-methoxy-4-hydroxyphenyl glycol as well as 3-methoxy-4-hydroxymandelic acid were not detectable demonstrates that both compounds arise from the action of monoamine oxidase on norepinephrine and epinephrine. On the basis of the evidence given here, we conclude that the neutral compound isolated from liver and kidney is identical with 3-methoxy-4-hydroxyphenyl glycol.

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[1] Goldstein, M., Friedhoff, A. J., and Sandler, G., *Experientia* (in the press).

[2] Axelrod, J., Kopin, I. J., and Mann, J. D., *Biochim. Biophys. Acta*, **36**, 576 (1959).

[3] Bertler, A., Carlsson, A., and Rosengren, E., *Acta Physiol. Scand.*, **44**, 273 (1958).

[4] Bush, I. E., *Biochem. J.*, 270 (1951).

Levels of Pyridine Nucleotides in Liver Poisoning

Gallagher and Simmonds[1] have shown that rats are protected against the lethal effects of carbon tetrachloride by prophylactic treatment with precursors of pyridine nucleotides. Such treatment was found also to protect against the loss of pyridine nucleotides from liver cells and to prevent necrosis of liver cells after dosing with carbon tetrachloride[2,3]. Rees, Spector and Sinha[4] found that the administration of 'Phenergan' (10-(2-dimethylamino-*iso*propyl) phenothiazine hydrochloride) to animals poisoned with carbon tetrachloride protects the liver cells against necrosis. In the present investigation we examined the effect of treatment with 'Phenergan' on the pyridine nucleotides of liver cells in carbon tetrachloride poisoning. The work was also extended to other liver poisons such as thioacetamide and dimethyl nitrosamine.

Table 1. Effect of 'Phenergan' on the Levels of Pyridine Nucleotides in the Liver in Rats poisoned with Carbon Tetrachloride

Treatment	E_{260} absorption
Nil	1·26
'Phenergan'	1·40
Carbon tetrachloride	0·65
Carbon tetrachloride + 'Phenergan'	1·13

Rats were killed 24 hr. after poisoning with carbon tetrachloride (1·25 ml./kgm. body-weight). 'Phenergan' dosing was at 0 and 6 hr. following poisoning (25 mgm. and 12·5 mgm./kgm. body-weight respectively). The E_{260} reading is corrected to 10 mgm. fat-free dry weight of liver extracted with 5 ml. 5 per cent w/v trichloracetic acid solution.

Table 1 shows that the administration of 'Phenergan' to rats poisoned with carbon tetrachloride prevented largely the fall in the level of pyridine nucleotide which followed the action of carbon tetrachloride alone. As was shown by Rees and Sinha (ref. 5, and unpublished work) the hepatotoxic agents carbon tetrachloride, dimethyl nitrosamine and thioacetamide lead to a different chronological pattern of leakage of liver enzymes into the blood stream. Consequently we determined the level of pyridine nucleotides in the liver and the serum at different times during the course of poisoning to determine the time relationships of the change.

Table 2 shows that as early as 5½ hr. after the administration of carbon tetrachloride there is a considerable fall in the E_{260} of the acid extracts of liver homogenates, but at this time there is no fall in the mitochondrial E_{260}. However, 10½ hr. after administration of carbon tetrachloride the mito-

Table 2. Levels of Pyridine Nucleotides in Liver and Serum following Poisoning of Rats with Carbon Tetrachloride, Thioacetamide and Dimethyl Nitrosamine

Treatment	Time (hr. after poisoning)	E_{260} Liver homogenate	Mitochondria	Serum
Nil	—	1·26	0·55	0·54
Carbon tetrachloride	5·5	0·97	0·55	—
	9	—	—	0·90
	10·5	0·82	0·34	—
	20	0·78	0·33	—
Thioacetamide	5·5	1·30	0·54	—
	9	—	—	0·52
	10·5	1·17	0·50	—
	20	1·18	0·59	—
Dimethyl nitrosamine	5·5	1·16	0·54	—
	9	—	—	0·66
	10·5	0·86	0·39	—
	20	0·68	0·40	—

Rats were dosed with carbon tetrachloride, 1·25 ml./kgm. body-weight; thioacetamide, 200 mgm./kgm. body-weight, and dimethyl nitrosamine, 100 mgm./kgm. body-weight. The E_{260} reading is corrected to 10 mgm./fat-free liver-weight for the liver homogenate, to 1 mgm. nitrogen for the mitochondria and to 1 ml. of serum. In all cases extraction of the tissues was made with 5 ml. 5 per cent w/v trichloracetic acid solution.

chondrial-levels had also fallen. This is in good agreement with the data on the leakage of enzymes from the liver in carbon tetrachloride poisoning. Rees and Sinha[5] have shown that at 6 hr. there is loss from the liver of cytoplasmic *iso*citric dehydrogenase and malic dehydrogenase and that the loss of mitochondrial enzymes occurs later, at about 12 hr. Consequently it appears that the initial effect of carbon tetrachloride is on the cell membrane, leading to a leakage of cytoplasmic constituents, and that mitochondrial damage occurs later in the course of the poisoning. In the case of thioacetamide poisoning, no fall in the E_{260} of either liver homogenates or mitochondria is observed during the 20-hr. course of the poisoning (Table 2). This is in contrast to the enzyme leakage from the liver cells and mitochondria, and suggests that the effect of carbon tetrachloride and thioacetamide on semi-permeable membranes may be different. Finally, dimethyl nitrosamine does not affect the E_{260} of either the liver homogenate or mitochondria at 5½ hr., but the E_{260} of both is depressed by 10½ hr. (Table 2). This finding agrees with the observed time relationships of the leakage of cytoplasmic constituents (Rees and Sinha, unpublished work) but indicates that pyridine nucleotides are lost from the mitochondria at a time when glutamic dehydrogenase is not leaking. This again suggests a type of damage to the semi-permeable membrane different from that occurring with the other two poisons.

Measurement of the serum E_{260} values at 9 hr. (Table 2) after poisoning with each of the above agents showed that there is a rise in the E_{260} following carbon tetrachloride poisoning, no change in the case of thioacetamide and a smaller rise in the case of dimethyl nitrosamine. These results are in good agreement with the levels of pyridine nucleotides in the livers of animals poisoned with each agent.

This work has shown that treatment with 'Phenergan', like pretreatment with precursors of pyridine nucleotides, maintains normal levels of pyridine nucleotides following carbon tetrachloride poisoning. However, it is probable that whereas the pyridine nucleotide precursors maintain this level by stimulating replacement of the nucleotides lost as a result of carbon tetrachloride poisoning, 'Phenergan' appears to act by preventing the leakage of pyridine nucleotides and of enzymes across the mitochondrial and cell membranes.

This investigation also shows that the loss of pyridine nucleotides from liver cells subsequent to carbon tetrachloride poisoning is an early event in the course of the poisoning and is not simply a result of necrosis of liver cells. The results with dimethyl nitrosamine and thioacetamide indicate that the three hepatotoxins have different effects on the semi-permeable membranes. In the case of carbon tetrachloride there is a loss of cytoplasmic and mitochondrial enzymes as well as cytoplasmic and mitochondrial pyridine nucleotides. Dimethyl nitrosamine leads to a loss of cytoplasmic enzymes but not of mitochondrial enzymes, and to a loss of pyridine nucleotides from both. Finally, thioacetamide, although leading to a loss of both cytoplasmic and mitochondrial enzymes, does not lead to the loss of cytoplasmic or mitochondrial pyridine nucleotides. Thus it appears that at least two types of membrane damage can occur, one leading to a loss of enzymes only (for example, thioacetamide), and the other to the loss of pyridine nucleotides only from the mitochondria, as in dimethyl nitrosamine, while a combination of these effects or a more general third group leads to the loss of both as in carbon tetrachloride poisoning.

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[1] Gallagher, C. H., and Simmonds, R. A., *Nature*, **184**, 1405 (1959).
[2] Gallagher, C. H., *Aust. J. Agric. Res.* (in the press).
[3] Gallagher, C. H., *Aust. J. Exp. Biol. Med. Sci.* (in the press).
[4] Rees, K. R., Spector, W. G., and Sinha, K. P., *J. Path. Bact.* (in the press).
[5] Rees, K. R., and Sinha, K. P., *J. Path. Bact.* (in the press).

Isolation of a δ-Lactone Compound from the Leaves of *Clitoria marina* Linn.

The plant *Clitoria marina* Linn. belongs to the Papilionaceae sub-group of Leguminosae, and is distinguished from *Clitoria ternatea* Linn. by its light-blue to almost white flowers. The leaves of the plant are used in medicine in India. A systematic chemical examination of the leaves has therefore been undertaken, and isolation of a δ-lactone compound from the alcoholic extract of the leaves has been achieved.

Sun-dried and powdered leaves were exhaustively extracted with 80 per cent ethyl alcohol in a Soxhlet for 36 hr. The extract was filtered hot, the filtrate reduced to half its original volume under reduced pressure and kept at 0° for 10 hr. when a solid substance settled down. The solid was separated, boiled with a large excess of ethyl alcohol, filtered and the filtrate again kept at 0° for 3 hr. The separated solid was refluxed with ethyl alcohol and a little activated animal charcoal and filtered hot. The filtrate on cooling deposited a white amorphous substance, m.p. 92° (yield 0·1375 per cent on dry weight basis). Further purification did not alter the melting point, and the purity of the product was established by chromatographic examination.

The substance was insoluble in water, cold ethyl alcohol, chloroform, petroleum ether and ether; but sparingly soluble in hot ethyl alcohol, benzene, pyridine and ethyl acetate. It did not decolorize bromine water or alkaline potassium permanganate and gave no acetyl derivative. It also did not reduce Fehling's solution and did not give tests for the presence of a keto group. It was found to be lævorotatory. Found: C, 78·95; H, 12·82 per cent, mol. wt. (Rast) 386; $C_{24}H_{34}O_2$ requires C, 79·18; H, 12·69 per cent, mol. wt. 394.

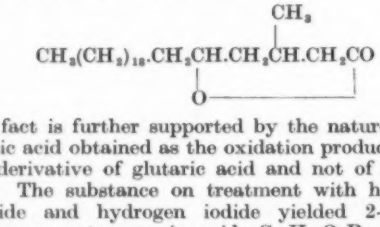
The bromo-derivative of the substance prepared by the usual bromination procedure was obtained as a pale yellow powder, m.p. 80°. It was soluble in benzene, chloroform and ether. Found: Br, 16·65 per cent. $C_{24}H_{31}O_2Br$ requires Br, 16·84 per cent. On treatment with freshly distilled hydrogen iodide (b.p. 126°), an ash-coloured product, m.p. 68°, was obtained. Found: I, 24·00 per cent. $C_{24}H_{31}O_2I$ requires I, 24·33 per cent.

The methyl ester of the substance prepared by usual esterification procedure gave a white amorphous powder, m.p. 74°, soluble in ether and chloroform.

Found: C, 76·13; H, 12·45 per cent. $C_{27}H_{54}O_3$ requires C, 76·21: H, 12·64 per cent. The methyl ester on acetylation gave a white amorphous product, m.p. 71°. Found: C, 74·36; H, 11·80 per cent; OAc, 9·25 per cent. $C_{29}H_{56}O_4$ requires C, 74·53; H, 11·90; OAc, 9·18 per cent.

Treatment with concentrated nitric acid, chromic acid and alkaline potassium permanganate separately gave two oxidation products in each case, a fatty acid and a dibasic acid afterwards identified as archidic acid, m.p. 75°. Found: C, 77·20; H, 12·66 per cent, mol. wt. 314. Calculated value for $C_{20}H_{40}O_2$: C, 76·92; H, 12·32 per cent, mol. wt. 312, and β-methyl glutaric acid, m.p. 84°. Found: C, 49·40; H, 6·92 per cent, mol. wt. 145. Calculated value for $C_6H_{10}O_4$: C, 49·33; H, 6·86 per cent, mol. wt. 146, respectively. The reactions of the amorphous substance with hydrogen bromide, hydrogen iodide and methyl alcohol proceeded at a slow rate.

On the basis of the above findings, the amorphous compound has been assigned a δ-lactone structure in preference to the γ-lactone.



This fact is further supported by the nature of the dibasic acid obtained as the oxidation product which is a derivative of glutaric acid and not of succinic acid. The substance on treatment with hydrogen bromide and hydrogen iodide yielded 2-methyl-4-bromo-*n*-pentacosanoic acid, $C_{26}H_{51}O_2Br$, and 2-methyl-4-iodo-*n*-pentacosanoic acid, $C_{26}H_{51}O_2I$, respectively. On esterification, the substance gave the methyl ester of 2-methyl-4-hydroxy-*n*-pentacosanoic acid, which further gave 2-methyl-4-hydroxymethyl-*n*-pentacosanoate on acetylation.

I am grateful to Prof. P. N. Wahi and to Prof. N. K. Chowdhury for their interest during these investigations.

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PHYSIOLOGY

Hydroxyproline and the Shrinkage Temperature of Collagen

It is well known that collagens from various sources have characteristic shrinkage temperatures (T_s), at which samples will contract abruptly in water or in 0·9 per cent saline solution. The T_s values of fish-skin collagens range from about 35° C. to 57° C., according to the mean temperature of the environment[1], while mammalian collagen has a T_s value of about 62° C., apparently irrespective of source. By an examination of the complete amino-acid analyses, these shrinkage temperatures have been correlated with the hydroxyproline content of the collagen; the lower the amount of hydroxyproline the lower the value of T_s (ref. 1). Hydroxyproline is considered to consolidate the collagen structure by forming hydrogen bonds between molecular chains. The data of ref. 1 have been plotted by us in Fig. 1 using the mean values of the shrinkage temperature quoted. These data are represented by circles and

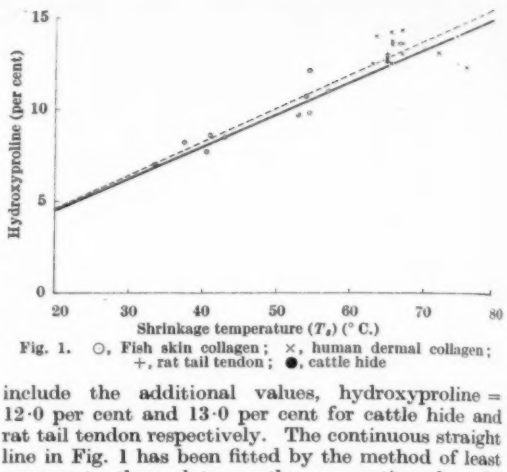

Fig. 1. ○, Fish skin collagen; ×, human dermal collagen; +, rat tail tendon; ●, cattle hide

include the additional values, hydroxyproline = 12·0 per cent and 13·0 per cent for cattle hide and rat tail tendon respectively. The continuous straight line in Fig. 1 has been fitted by the method of least squares to these data on the assumption that the relation between hydroxyproline and T_s is linear.

Also included in the graph are the data of Hall and Reed[2], who determined the T_s versus hydroxyproline content of human dermal collagen. Hall and Reed concluded from their experiments that there was no correlation between hydroxyproline and T_s. However, as can be seen from Fig. 1 their data fall in their appropriate position with respect to the line drawn to the circle data, and it is clear why no correlation could be seen from their data alone—the range of hydroxyproline was too narrow. It is interesting and significant to find collagen from such widely differing sources following such a simple relation, which supports Takahashi's[1] and Gustavson's[3] original contention.

If the data of Takahashi and Hall and Reed are together fitted by a least-square method the dotted line in Fig. 1 is obtained. Its close proximity to the first line again shows the close correlation in behaviour of different collagens.

If the dotted line in Fig. 1 is accepted as valid then it is possible to make some speculations about the biological implications of a below-normal hydroxyproline content in human collagenous structures. For example, it has been reported by Bowes, Elliott and Moss[4] and others[4] that the hydroxyproline content of fibrinoid tissue from rheumatic fever patients and in rheumatoid arthritis was lower than in normal tissue. They quoted a value of 8·3 per cent for fibrinoid tissue which, according to Fig. 1, would give the collagen a T_s value of 40° C. As 40° C. is close to normal blood temperature and could be reached during a fever it is suggested that these rheumatic effects are the result of a structural breakdown due simply to temperature. It is not necessary that the actual T_s values be reached for, as Weir[5] has shown, shrinkage is a rate process, and given sufficient time shrinkage will occur at temperatures about 5° C. below the instantaneous shrinkage temperature (our T_s). Furthermore, if the structure happens to be under tension, then the denaturation process is likely to be accelerated (although the T_s will be increased owing to the fact that extra tension has now to be generated in order to overcome the applied tension before contraction can take place). This idea has been discussed extensively by us elsewhere[6] and applied to the phenomena of 'heart

murmurs'. This stress mechanism could be a factor in explaining the predominance of rheumatic complaints in the joints.

Finally, it has been reported by Briscoe and Loring[7] that the hydroxyproline content of the collagen of human lung increases with age. If this increase applies to collagenous structure generally, then it would appear that the body has a built-in defence mechanism for resisting denaturation, and only the young would be vulnerable to immediate effects of body temperatures higher than normal. In support of this view there is evidence, for example, that the high temperatures associated with rheumatic fever are more damaging to young patients than to adults. On the other hand, since the process of denaturation is rate-controlled, the time factor becomes important in the manifestation of rheumatic symptoms when the effect of temperature higher than normal is not involved. Thus where the hydroxyproline content is close to normal but slightly below it, many years would elapse before denaturation was complete, and this is a possible explanation of the fact that rheumatism is predominantly a disease of the adult.

In other words, if for hereditary or other reasons the increase of hydroxyproline (presumably by conversion of proline to hydroxyproline) with age does not occur (or the increase is slower than normal) then the individual concerned is likely to become a rheumatic. The above views may explain why many symptoms are common to both rheumatoid arthritic and rheumatic fever patients, for example, cardiac lesions, swelling and pain in joints. In both cases collagen has been denatured.

In this communication we have only considered the denaturation of collagen as a function of temperature. It is realized that other denaturation mechanisms occur; these will be discussed in a later publication.

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[1] Takahashi, T., quoted in "The Chemistry and Reactivity of Collagen", by Gustavson, K. H., 224 (Academic Press, Inc., New York, 1956).
[2] Hall, D. A., and Reed, R., *Nature*, **180**, 243 (1957).
[3] Gustavson, K. H., *Nature*, **175**, 70 (1955).
[4] Bowes, J. H., Elliott, R. G., and Moss, J. A., in "Nature and Structure of Collagen", edit. by Randall, 199 (Butterworths, London, 1953).
[5] Weir, C. E., *J. Amer. Leather Chem. Assoc.*, **44**, 108 (1949).
[6] Rigby, B. J., Hirai, N., Spikes, J. D., and Eyring, H., *J. Gen. Physiol.*, **43**, 265 (1959).
[7] Briscoe, A. M., and Loring, W. E., 136th Meeting Amer. Chem. Soc., Sept. 13–18, 1959.

Effect of Electronarcosis on Oxygen Consumption and Carbon Dioxide Output

In assessing changes of vital function during electronarcosis, we measured oxygen consumption and carbon dioxide output in an experiment in rabbits. The measured values were considered an important index for the evaluation of metabolic changes during electronarcosis.

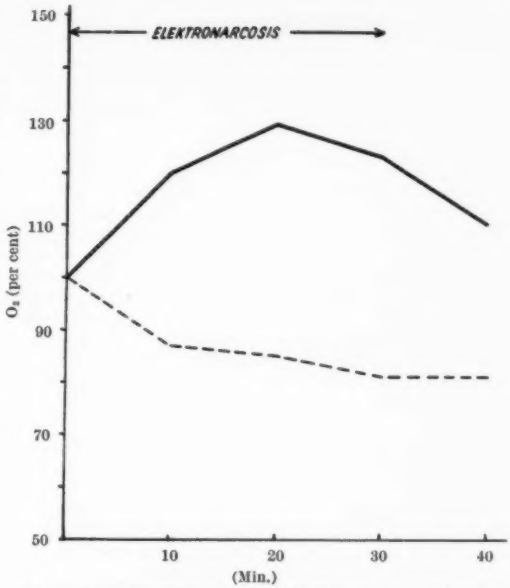

Fig. 1. Oxygen consumption during electronarcosis. ——, During electronarcosis; . . . ., control

In 10 rabbits the resting values of oxygen consumption and carbon dioxide output were measured. The average value from a 15-min. measurement was taken as 100 per cent. Having carried out these measurements we induced electronarcosis by combining the Leduc and direct current (tension 50 V., frequency 100 c./sec. admixture of the direct current 15 per cent, relation of impulse length to break 1 : 9, intensity 0·6 m.amp.). The current is applied through external bitemporal electrodes with felt covering soaked in sodium chloride solution. The values were followed for 15 min. before electronarcosis, for 30 min. of the electronarcosis duration and for 15 min. afterwards. The same animals served as controls for the same length of time but without electronarcosis.

(1) *Oxygen consumption.* A clear rise of oxygen consumption during electronarcosis was observed in all cases. The maximum is attained 20 min. after the beginning of electronarcosis and reaches about 150 per cent of the original value. In the following course of electronarcosis oxygen consumption decreases slightly, but after 30 min. it is still more than 120 per cent. When the electronarcosis is interrupted the oxygen consumption falls abruptly. Average values in time are shown in Fig. 1.

(2) *Carbon dioxide output.* The output increases during electronarcosis by a rise which is even sharper than that of oxygen consumption. A second rise of the output occurs after interrupting the electronarcosis. The time course is given in Fig. 2.

(3) The values of the respiration quotient can be elaborated from the preceding measurements. The curve in time follows roughly that of the preceding curve, but the rise after interrupting the narcosis is more marked.

The rise of oxygen consumption is striking, considering its fall in all types of drug narcosis. The explanation for this might be found in an increased muscle tone which can be proved especially at the

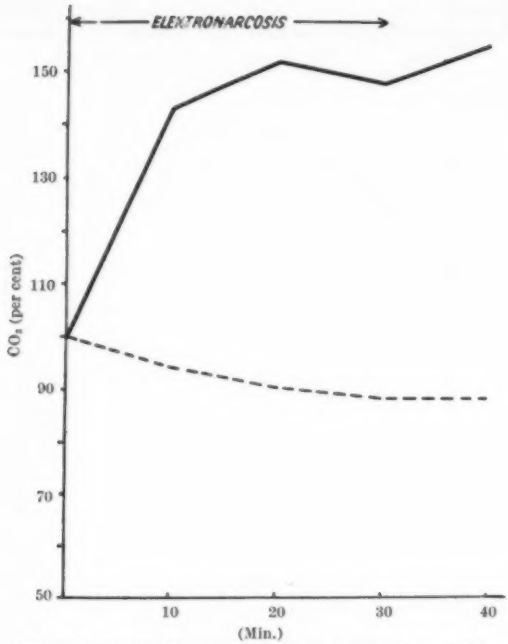

Fig. 2. Carbon dioxide output during electronarcosis. ——, During electronarcosis; ...., control

beginning of electronarcosis. In accordance with that a gradual fall of the values can be observed after 20-min. duration of electronarcosis. When the animals awaken, the consumption falls rapidly. The fall of oxygen consumption in the control group without electronarcosis can be attributed to a decreased metabolism of the resting animal whose movements have been impeded.

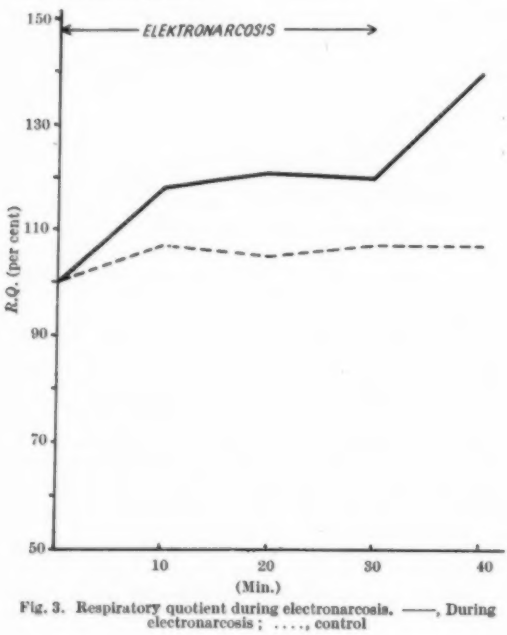

Fig. 3. Respiratory quotient during electronarcosis. ——, During electronarcosis; ...., control

The rise in carbon dioxide output is the result of an increased tissue metabolism evident already from the changes in oxygen consumption.

The course of values measured after interrupting the electronarcosis implies that no oxygen debt ensues during the electronarcosis. The changes of the respiration quotient leave room for an assumption that the tissue metabolism changes during electronarcosis are not only quantitative but qualitative as well.

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Role of Mucoid Substances of the Aorta in the Deposition of Lipids

The mechanism of deposition of lipids in the vessel-wall seen from the point of view of the pathogenesis of atherosclerosis represents the central problem of the latter. In agreement with numerous data[1–4], our previous investigations[5] proved that in the morphogenesis of both human and experimental atherosclerosis the deposition of lipid substances in the aorta is preceded by an increase of metachromatically stainable mucoid substance.

By means of immuno-electrophoresis it could be proved that one part of the lipids in the aortic intima is identical with plasma-β-lipoprotein[6].

Bernfeld's[7] investigations have proved the formation of specific complexes between polyanions of high molecular weight and β-lipoprotein. Based on this, we have supposed a kind of complex-formation between the substances of similar chemical character, accumulated in the aortic wall (mucoids) and the plasma-β-lipoprotein. Thus the formation of this specific complex might be considered as the beginning of the process of lipid deposition. Our supposition finds support in the histological findings that the deposition of lipids mainly occurs in those areas of the aorta which are rich in metachromatically stainable substances.

Based on these facts we have investigated whether the mucopolysaccharides of sclerotic human aortic intima dispose of the ability of binding β-lipoprotein specifically.

Employing the method of Dyrbye and Kirk[8] we have isolated the mucopolysaccharides of sclerotic human aortic intima. The isolated mucopolysaccharides may be separated by paper-electrophoresis into two fractions: one of them having a higher mobility, being periodic acid–Schiff-negative and containing a considerable amount of sulphate, and the other with a lower mobility, periodic acid–Schiff-positive, with mere traces of sulphate.

The mixture of mucopolysaccharides obtained in this way was electrophorized after having been mixed with pure human β-lipoprotein. We have stated that the β-lipoprotein moves together with the aortic mucopolysaccharide fraction of lower mobility (Fig. 1).

After having mixed the aortic mucopolysaccharides with native (normal) human plasma and electro-

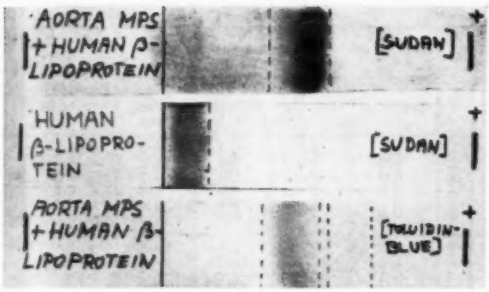

Fig. 1. Interaction of pure human β-lipoprotein with aortic mucopolysaccharides. Veronal buffer, *p*H 8·6, 16 hr., 200 V., 10 m.amp.

phorized the mixture we have found that the β-lipoprotein fraction of the plasma also in this case moved together with the mucopolysaccharide fraction of lower mobility. In this case, however, the interaction causes a retention because of the higher mobility of the native β-lipoprotein (Fig. 2). The mobility of plasma-α-lipoproteins does not show any change. This circumstance proves that mucopolysaccharides of the aortic intima did not bind the plasma-α-lipoproteins. It is in conformity with the fact that plasma-α-lipoprotein cannot be shown to be present in the sclerotic aortic intima with the method of immuno-electrophoresis.

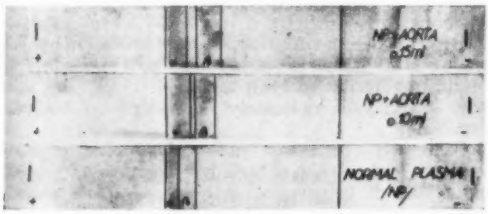

Fig. 2. Interaction of normal human plasma-lipoproteins with aortic mucopolysaccharides. Stained with sudan black. 400 V., 30 m.amp., 2 hr. Borate buffer, *p*H 8·6

The present investigations support our supposition that the basis of deposition of plasma-β-lipoproteins in the sclerotic aortic intima may be found in the ability of binding plasma-β-lipoprotein of some specific mucopolysaccharides of the aortic intima.

Details and discussions of these problems will be published elsewhere.

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[1] Schultz, A., *Virchow's Arch. Pathol. Anat.*, **239**, 415 (1922).
[2] Faber, M., *Arch. Pathol.*, **48**, 342 (1949).
[3] Rinehart, J. F., in "Connective Tissue in Health and Disease", edit. by Munksgaard, Ejnar, 239 (1954).
[4] Buck, R. C., *Arch. Pathol.*, **58**, 576 (1954).
[5] Gerő, S., Farkas, K., Gergely, J., Jakab, L., Székely, J., and Virág, S., Orv. Hetil, Budapest (in the press).
[6] Ott, H., Lohss, F., and Gergely, J., *Klin. Wschr.*, **36**, 383 (1958).
[7] Bernfeld, P., Donahue, V. M., and Berkowitz, M. E., *J. Biol. Chem.*, **226**, 51 (1957).
[8] Dyrbye, M., and Kirk, J. E., *J. Gerontol.*, **12**, 20 (1957).

Effect of Lysergic Acid Diethylamide on Larval Growth

Lysergic acid diethylamide is known to be hallucinogenic in man[1] and to produce behavioural aberrations in experimental animals. When administered to spiders[2], lysergic acid diethylamide improved the regularity and angles in the pattern of the web. In the liver fluke (*Fasciola hepatica*) lysergic acid diethylamide intensified the motility[3]. However, in most cases the effects of lysergic acid diethylamide decrease shortly after withdrawal of the drug. In humans the effects may persist as long as 24 hr. in many cases[4]. Increased resistance to lysergic acid diethylamide on repeated administration has been reported[5]. Our present investigation shows that incorporation of lysergic acid diethylamide with the food caused marked reduction in growth of larvæ of *Tenebrio molitar*, which was not reversed by returning the larvæ to normal diet.

Adult larvæ of the same age and weight were carefully selected from a stock and divided into two groups of thirteen each. Group I received the basal diet consisting of 77 per cent corn meal, 15·4 per cent bran, 7·6 per cent wheat germ supplemented with 1 per cent of yeast extract. Group II received the same diet except that 2·5 mgm. of lysergic acid diethylamide were added per 10 gm. of diet. The larvæ were returned to fresh diet every week. The growth-rates of these two groups are presented in Table 1, which shows the inhibitory effect of lysergic acid diethylamide on the growth of the larvæ.

Experiments have been carried out to test the duration of the effect of lysergic acid diethylamide. Small larvæ were selected and placed on the lysergic acid diethylamide diet for the first four weeks and then returned to the control diet. The results are presented in Table 2. The toxic effect of lysergic acid diethylamide on the growth of the larvæ persists long after the withdrawal of the drug. This long-standing effect of lysergic acid diethylamide is different from that of a vitamin deficiency where fast growth-rate

Table 1. Effect of Lysergic Acid Diethylamide on Larval Growth

No. of week	Average weight per larva	
	Group I (control)	Group II (fed with the drug)
Start 0	20·6	19·3
1	29·8	22·4
2	40·3	23·1
3	51·3	23·5
4	61·5	26·2
5	71·0	27·9

Table 2. Irreversibility of the Effect of Lysergic Acid Diethylamide

No. of week	Average weight per larva		
	Group I Control	Group II Drug diet, first four weeks only	Group III Drug plus reserpine, first four weeks only
Start 0	2·8	3·0	2·5
1	3·7	3·6	2·9
2	4·8	4·2	3·0
3	6·6	4·3	3·5
4	8·9	4·9	4·2
5	12·4	5·8	4·7
6	16·7	7·0	5·3
7	20·6	8·8	5·9
8	27·8	11·3	6·3
9	36·1	14·1	7·2
10	45·0	17·7	8·4

occurs on the administration of the vitamin. Also this may indicate that the effect of lysergic acid diethylamide may last longer than usually presumed. Further, addition of reserpine did not reduce the effect of lysergic acid diethylamide on the growth of the larvæ (Table 2). While no larvæ died on the control diet, on the lysergic acid diethylamide and the drug plus reserpine diets the mortality-rate was usually 25 per cent in the first four weeks and none thereafter.

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[1] Rothlin, E., and Cerletti, A., "Pharmacology of LSD-25" (Grune and Stratton, New York, 1956).
[2] Witt, P. N., *Experientia*, **7**, 310 (1951).
[3] Mansour, T. E., *Brit. J. Pharmacol.*, **12**, 406 (1957).
[4] Becker, A. N., *Wien. Z. Nervenh.*, **2**, 402 (1949).
[5] Freedman, D. X., Aghajanian, G. K., and Ornitz, E. M., *Science*, **127**, 1173 (1958).

Urinary Excretion of Œstrogens in Cases of Chronic Prostato-vesiculitis

The prostate gland is a sensitive target organ for testicular hormone, the production of which is a prerequisite for the normal development and function of the gland. The same relationship is consequently reflected in what concerns the composition of prostatic secretion. Thus, the quantitative occurrence of prostatic acid phosphatase[1–3] and citric acid[4] is intimately dependent on the endocrine function of the testes.

Prostatic secretion also contains proteins, of which it has been possible to identify different fractions by paper electrophoresis[5]. The mutual relationship of these fractions showed relatively fixed correlation. In some cases of chronic prostato-vesiculitis a rather characteristic protein pattern was obtained[5].

As it is evident that the composition of prostatic secretion is dependent on the activity of testicular hormone, and as the protein composition of the secretion differs from the normal in many cases of chronic prostato-vesiculitis, it was considered worth while studying the excretion of œstrogens in individuals suffering from this disease.

The material consisted of 17 men in the age-group 23–43 years. All were recorded as cases of chronic prostato-vesiculitis. Secretion was taken from the gland for paper electrophoretic examination of the protein components[5]. An additional test was carried out for reducing substances to reveal any possible mixture of vesicular secretion[6].

Hormone titrations were performed on a 48-hr. specimen of urine with regard to the following substances: (1) œstradiol; (2) œstrone; (3) œstriol. Brown's method using saponification was used[7,8].

Furthermore, biological titrations of gonadotrophins were carried out (uterine weight in mice).

Six of the 17 individuals examined showed titre values for œstrogen substances lying well within the limits given by Brown for normal men[8]. Eleven, however, presented higher titres of these substances (Table 1).

The urinary excretion of gonadotrophins was noticeably high in 5 of this latter group (Table 1).

Table 1

No.	Urinary excretion of Œstrogens γ/24 hr.				Gonadotrophins (M.U./24 hr.)
	Œstradiol	Œstrone	Œstriol	Total œstrogens	
1	1·5	4·5	2·4	8·4	> 6·5 <13
2	1·5	5·4	4·2	11·1	> 6·5
3	0·0	3·3	5·4	8·7	> 6·5 <13
4	1·8	0·0	6·0	7·8	> 6·5
5	2·1	5·4	2·4	9·9	> 6·5
6	2·1	7·5	1·8	11·4	> 6·5 <13
7	5·1	8·1	5·4	18·6	>13 <96
8	5·1	12·6	10·8	28·5	< 6·5
9	6·3	9·0	5·4	20·7	>96 <960
10	3·6	11·1	4·2	18·9	> 6·5 <13
11	12·0	7·5	4·8	24·3	>13 <96
12	5·4	7·8	4·8	18·0	>13 <96
13	2·6	7·5	22·2	32·3	> 6·5 <13
14	3·8	8·4	9·6	21·8	< 6·5
15	5·4	6·3	3·6	15·3	> 6·5 <13
16	6·3	9·0	4·2	19·5	> 6·5 <13
17	10·5	9·3	8·4	28·2	>13 <96
	Range and mean values according to Brown (ref. 8)				Normal value
	0·0–6·3 *M* 1·5	3·0–8·2 *M* 5·4	0·8–11·0 *M* 3·5	6·0–17·8 *M* 10·3	<13

A comparison now between the electrophoretic diagrams of all the cases with normal urinary titres (Fig. 1) with those with more or less increased œstrogen excretion (Fig. 2) brings out a difference. The two protein fractions nearest to the starting point are in the former cases comparatively less prominent, while in the latter they have a dominant character found in many cases of chronic prostato-vesiculitis[5].

By way of introduction, the point was made that the prostate gland in its capacity as a secondary sex organ in relation to both its development and secretory activity is ultimately dependent on testicular hormone.

Evidently, in many cases of chronic prostato-vesiculitis there occur high œstrogen urinary excretions. Since in certain of these cases the gonadotrophin titres are similarly increased, this might express an inhibition of testosterone production.

This circumstance might be interpreted as primary, making the gland susceptible to infection. Or, on the other hand, it might be a consequence of a primary prostatic infection. Finally, as a new point of view, a reduced testosterone activity might influence the target gland to develop an inflammatory reaction, clinically interpreted as a state of infection.

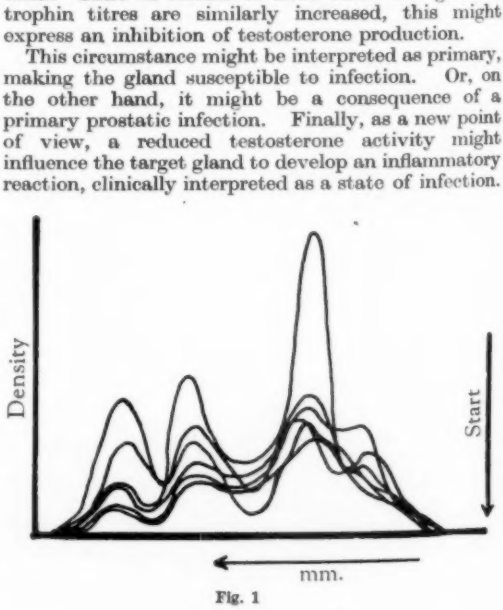

Fig. 1

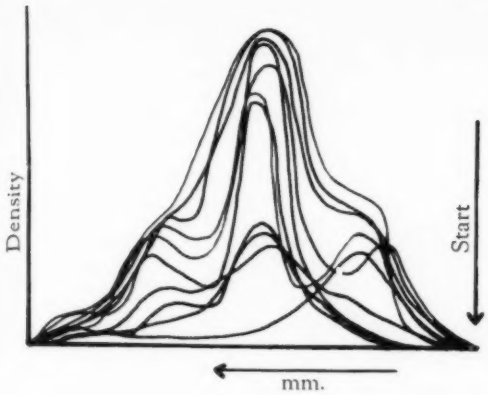

Fig. 2

My thanks are due to Dr. B. H. Persson for valuable help in performing the hormone determinations.

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[1] Gutman, A. B., and Gutman, E. B., *Proc. Soc. Exp. Med. and Biol.*, **41**, 277 (1939).
[2] Scott, W. W., and Huggins, C., *Endocrinol.*, **30**, 107 (1942).
[3] Engberg, H., Andersson, E., Sury, B., and Raft, J., *Endocrinol.*, **5**, 42 (1947).
[4] Humphrey, G. F., and Mann, T., *Nature*, **161**, 352 (1948).
[5] Nylander, G., *Acta chir. Scand.*, **109**, 473 (1955).
[6] Mann, T., *Biochem. J.*, **40**, 481 (1946).
[7] Brown, J. B., *Biochem. J.*, **60**, 185 (1955).
[8] Brown, J. B., *Mem. Soc. Endocrinol.*, **3**, 1 (1955).
[9] Brown, J. B., Bulbrook, R. D., and Greenswood, F. C., *J. Endocrinol.*, **16**, 49 (1957).

Eosinophil Leucocyte-attracting Effect of Histamine in Skin

WHEN histamine is injected into skin, one of the effects that follows is an attraction of eosinophil leucocytes. A number of reports of this have been published[1–5]; but none of these papers discussed the effects of widely differing rates of dosage, nor the varying degrees of eosinophilic infiltration around the injection site. The purpose of this communication is to report upon the extent of the eosinophil infiltration which follows various doses of histamine as the acid phosphate into the skin of horses.

The skin of the necks of cross-bred ponies was used. The sites for injection and subsequent biopsy were so placed that the centres of the sites were at least 10 cm. apart. The intradermal injections consisted of the required amounts of histamine acid phosphate (B.D.H.) dissolved in 0·2 ml. sterile physiological saline. The development of œdema was measured and recorded, and the skin biopsies were made 4 hr. after injection. The method has been described in detail elsewhere[3].

Six ponies were prepared each with 11 test sites for biopsy on both sides of the neck, a total of 132 sites. Injections of histamine were given so that doses of 0·01 μgm. to 20 mgm. were dispersed at random among the available sites on each pony, while two control sites in each pony received the saline vehicle only. From the skin biopsies, sections were prepared, and counts of the eosinophils occurring in 25 consecutive high-power fields were made. The results are expressed as an average number of eosinophils in each field (Fig. 1). Each observation is plotted with the standard deviation.

In the conditions of this experiment, a maximal eosinophilic infiltration occurred with doses approximating to 100 μgm. A second high response occurred with doses of 5 mgm. Some infiltration with eosinophils occurred with a dose as low as 0·05 μgm., while the control sites which did not receive any histamine had an average eosinophil count less than 0·1 cell per high-power field.

In another experiment a circle of 20 cm. diameter was prepared and shaved on the lateral aspect of the neck of a cross-bred pony. An intradermal injection of 5 mgm. of histamine acid phosphate was made in the centre of the circle and the precise injection site marked. After 4 hr., the œdema was carefully recorded on a scale drawing and skin biopsies were taken along 4 radii of the circle at 1-cm. intervals. The eosinophilic infiltration of each was assayed and the results are shown in Fig. 2. It was found that two areas of œdema could be recognized: a primary zone around the site of injection and a secondary zone ventral to this, presumably due to the spread of the histamine by gravity to areas below the primary site.

Replicates of this experiment using 15 mgm. of histamine acid phosphate gave an essentially similar result except that both the œdema and the eosinophilia extended over a slightly larger area. A dose of 100 μgm. gave a similar picture so far as the inner 5-cm. radius of the circle was concerned, but there was no secondary œdema.

In the skin of horses, intradermal injections of histamine produce a degree of eosinophilic infiltration which is related to the dose of histamine. From about 0·5 μgm. to 50 μgm. the increase is linear. It is of interest that doses greater than 200 μgm. produce less eosinophilic infiltration than do smaller doses, but presumably no local concentration of histamine approaching these levels could occur in life. The secondary œdema which follows intradermal injection

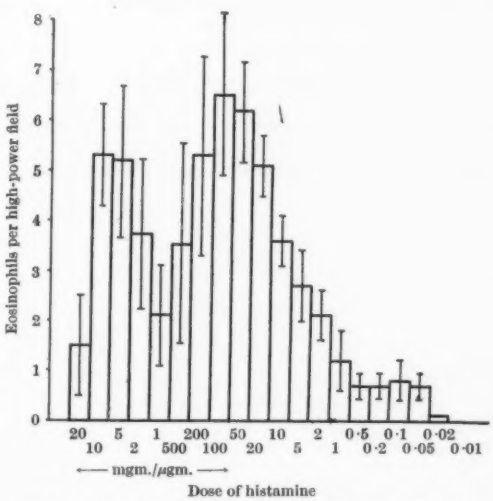

Fig. 1. The eosinophilic infiltration of horse skin after intradermal injections of various doses of histamine acid phosphate. Each normogram is the mean of six replicates on different animals, plotted with the standard deviation

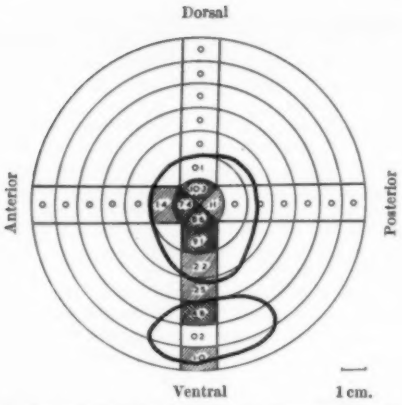

Fig. 2. The concentration of eosinophils around an intradermal injection of histamine on the neck of a pony. Biopsies were made 1 cm. apart on four radii of a circle the centre of which was the site of injection. The limits of the two areas of œdema which formed are indicated by the heavy line. The figures indicate the concentration of eosinophils in each biopsy specimen

of large doses of histamine is accompanied by an increase in eosinophilic content of the tissue over approximately the same area.

The *p*H of the injected histamine acid phosphate is not critical, since titration of the solution to neutral *p*H with sodium bicarbonate produced only minor reduction of the response. Injections of an acid phosphate (that is, without histamine base) did not produce eosinophilic infiltration of the tissue concerned.

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[1] Archer, R. K., *J. Path. Bact.*, **72**, 87 (1956).
[2] Archer, R. K., *J. Path. Bact.*, **78**, 95 (1959).
[3] Kline, B. S., Cohen, M. B., and Rudolph, S. A., *J. Allergy*, **3**, 531 (1932).
[4] Knott, F. Q., and Pearson, R. G. B., *Guy's Hosp. Rep.*, **84**, 230 (1934).
[5] Rick, R. F., *Australian J. Agric. Res.*, **5**, 109 (1954).

HÆMATOLOGY

Effect of 6-Mercaptopurine on the Net *in vitro* Gas Production of Sensitive and Resistant *L*1210 Mouse Leukæmia Cells

It was recently suggested that it might be possible to develop an *in vitro* test of the sensitivity of leukæmic cells to various chemotherapeutic agents based upon the hypothesis that the concentrations of drugs which would inhibit the oxygen-uptake of sensitive cells might not affect cells which were resistant[1]. In an attempt to test this hypothesis some experiments with sensitive and 6-mercaptopurine-resistant *L*1210 mouse leukæmic cells were carried out.

A preliminary experiment in which sensitive strain cells were incubated *in vitro* at 37° C. in a Warburg apparatus showed that oxygen-uptake was irregular, but that the rate of net gas production was constant. A straight-line relationship between net gas output (carbon dioxide production less oxygen utilization) and time continued for more than 7 hr., and was considered a suitable parameter for a study of the

Fig. 1. The effect of 6-mercaptopurine on the net gas production of sensitive *L*1210 cells
●, and vertical shading, sensitive cells: no drug control; ×, and oblique shading, sensitive cells: 6-mercaptopurine

in vitro action of drugs. The effect of 6-mercaptopurine on sensitive cells was studied in three experiments. Two vessels containing cells alone and two containing cells and 6-mercaptopurine (10 *M* twice and 6 *M* once) were set up each time. Between 7 and 15 million cells in 5 ml. of a mixture of medium 199 (80 per cent) and normal human serum (20 per cent) were used and the drug added between 30 and 45 min. before the first readings. Fig. 1 summarizes the results. The thick lines represent the averages of the six readings and the shaded area the ranges. 6-Mercaptopurine caused a decrease in the net gas production; this effect noticeable at 3 hr. is clearly significant by 5 hr.

When a 6-mercaptopurine-resistant strain of *L*1210 cells became available through the courtesy of Dr. L. W. Law, of the U.S. National Cancer Institute, the experiments were repeated. Under the same experimental conditions the *in vitro* gas production of

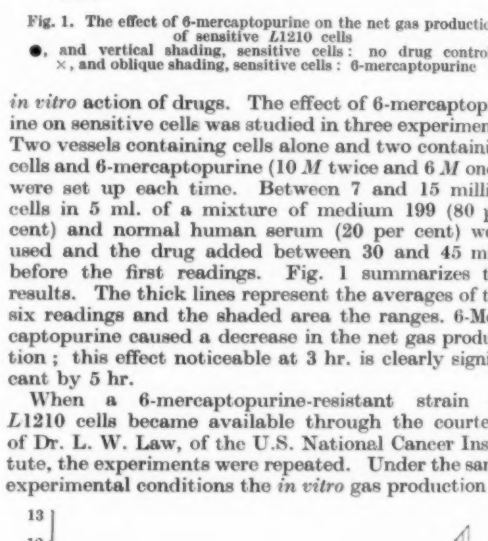

Fig. 2. A comparison of the net gas production of sensitive and 6-mercaptopurine-resistant *L*1210 cells
● and vertical shading, sensitive cells: no drug control; □ and oblique shading, sensitive cells: 6-mercaptopurine

the resistant cells was found to differ considerably from that of the sensitive cells.

This difference is illustrated in Fig. 2. The net gas production of the resistant cells was recorded on three separate occasions utilizing 2, 2 and 4 vessels, respectively. The average finding of the eight recordings is given in the thick line and the range by the shaded areas. On one occasion sensitive cells tested at the same time gave results which fell into the range illustrated in Fig. 1.

The effect of 6-mercaptopurine on resistant cells was also studied. The net gas production in these circumstances fell within the range for the controls. It is not, however, possible to draw any firm conclusions from this since the readings have a rather wide range around unity and so any effect of the drug would be difficult to detect.

While no support has been gained for the hypothesis that stimulated this investigation, two points of interest have emerged. First, a simple reproducible system for the investigation of the effect of 6-mercaptopurine upon sensitive *L*1210 cells has been found, and secondly, a profound difference in the respiratory behaviour of sensitive and 6-mercaptopurine-resistant *L*1210 cells has been observed.

This work was carried out during the tenure of a Leukæmia Society Fellowship. I am grateful to Mr. D. E. S. Truman for his help with manometry, and to Miss M. Barrett of the Wellcome Research Laboratories for sending me mice inoculated with *L*1210 cells. Messrs. Burroughs Wellcome kindly supplied the 6-mercaptopurine.

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[1] Woodliff, H. J., and Davis, J. M. G., *Nature*, **185**, 477 (1960).

Electrophoretic Separation of Certain *in vitro* and *in vivo* Reactions of Rabbit Anti-Mouse Erythrocyte Serum

Rabbit anti-mouse erythrocyte serum provided an excellent model for the study of *in vitro* and *in vivo* immunological reactions. In addition to its strongly hæmolytic and agglutinating properties for, and its combining ability with, mouse erythrocytes, this antiserum readily produces anæmia in mice, a species especially suitable for this purpose.

These reactions were studied as quantitatively as possible under comparable conditions: hæmolysin was measured in 50 per cent hæmolytic ($H/2$) units in a total volume of 2 ml. Approximately 5×10^7 erythrocytes were lysed by one $H/2$ unit of hæmolysin. Saline agglutinin was titrated by a 1·26-fold dilution system and recorded in scores ($++++ = 10$, $+++ = 8$, $++ = 5$, $+ = 3$, $+w = 1$). In this way, the end-points were spaced more closely and the strength of the serum was represented more precisely. The combining ability was detected by using unlabelled and fluorescein *iso*cyanate-labelled sheep anti-rabbit globulin serums. With the former, an indirect anti-globulin test was done and the agglutinating titres were recorded. The formalinized mouse erythrocytes were sensitized with the anti-mouse erythrocyte serum or its fractions. It was then coated with the fluorescent serum, washed, and examined microscopically with ultra-violet light. The brightness of the green fluorescence was recorded as − (negative), +, ++, +++, ++++ (positive).

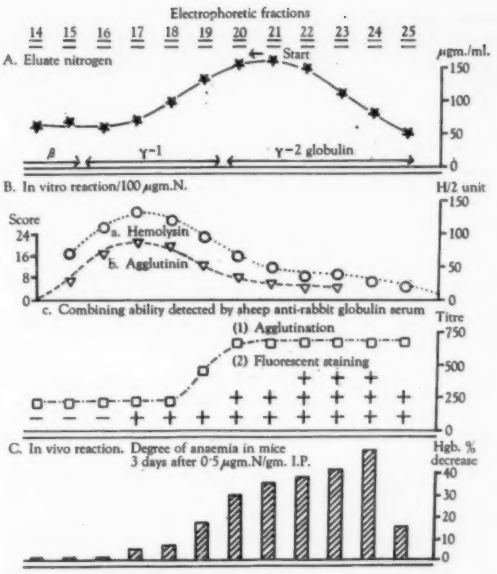

Fig. 1. Association of immunological reactions with electrophoretic fractions of rabbit anti-mouse erythrocyte serum

Groups of mice were injected intraperitoneally with 0·01 ml. of different dilutions of rabbit anti-mouse erythrocyte serum per gram of mouse. The potency of the serum was measured by the degree of anæmia at its maximum, which was usually 3 days after the injection. The degree of anæmia was expressed in terms of percentage hæmoglobin decrease, as compared with the pre-injection value. Hæmoglobin was determined with the cyan-methæmoglobin method using a red-cell-counting pipette to minimize the amount of blood required.

Rabbit anti-mouse erythrocyte serum was prepared by injecting rabbits intraperitoneally with 1 ml./kgm. of a 10 per cent suspension of thoroughly washed erythrocytes. Injections were repeated four times weekly in the first and third week. Antiserum was collected 7 days after the last injection. Fractionation of serum was accomplished by starch-zone electrophoresis[1]. At the end of each run, the 50-cm. long starch block was divided evenly into 25 fractions. Buffered saline eluates from each fraction were adjusted to contain equal numbers of μgm. of protein nitrogen before their activity was tested. Similar results were observed with fractions of 5 antisera. An example is shown in Fig. 1 in which only the β- and γ-globulins (fractions 14 to 25) are listed. Samples from other fractions were also tested concurrently but found to be negative. The association of the various immunological reactions with the globulin fractions can be summarized as follows.

In *in vitro* studies, the hæmolysin and saline agglutinin were similarly distributed. Most of them were associated with the γ-1 globulin fractions. The combining ability as demonstrated by unlabelled and fluorescein-labelled sheep anti-rabbit globulin serums was associated mainly with γ-2 globulin fractions. These findings are essentially the same as those reported by the isotope-tracing technique in the rabbit anti-sheep erythrocyte system[2].

In *in vivo* experiments, the degree of anæmia in mice increased progressively from fractions 19 to 24

which contain γ-2 globulins. It is obvious that the anæmia-producing factor was more closely associated with the combining ability than with saline agglutinin or hæmolysin.

Successful separation of the component responsible for the anæmia from the saline agglutinin and hæmolysin in the rabbit anti-mouse erythrocyte serum was demonstrated by means of starch-zone electrophoresis.

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[1] Kunkel, H. G., and Slater, R. J., *Proc. Soc. Exp. Biol. and Med.*, **80**, 42 (1952).
[2] Stelos, P., and Talmage, D. W., *J. Inf. Dis.*, **100**, 126 (1957).

Sedimentation Characteristics of the γ-Chain Hæmoglobin (Hæmoglobin 'Bart's')

FROM the X-ray analysis of horse hæmoglobin by Perutz and his collaborators[1,2] and Ingram's examination of the peptides formed by tryptic digestion of human hæmoglobin[3], it can be concluded that human hæmoglobin is composed of two identical half-molecules, each containing approximately 280 amino-acids. Rhinesmith, Schroeder and Pauling[4] showed that normal adult hæmoglobin (*A*) consisted of four polypeptide chains of only two types. One of these types—afterwards named α-chain—had a terminal valyl–leucyl residue. The β-chains were identified by Rhinesmith, Schroeder and Martin[5] as carrying a terminal valyl–histidyl–leucyl residue. A third type of chain, later named γ-chain, was observed in human fœtal hæmoglobin (*F*) by Schroeder and Matsuda[6]. It carried a terminal glycyl residue. The other hæmoglobin *F* chain, already known to carry a terminal valyl residue[6–8], was shown by Hunt[9] to be identical with the α-chain of hæmoglobin *A*.

Differences between adult hæmoglobin variants have in general been seen to be due to an alteration in one amino-acid of either the α- or the β-chain[10]. A new type of hæmoglobin variant was described by Jones, Schroeder, Balog and Vinograd[11] when they found that hæmoglobin *H* consisted solely of β-chains.

In 1958 the hæmoglobin variant 'Bart's' was described[12], and, in view of its properties, was considered to be an abnormal fœtal hæmoglobin. This pigment was found to be the fœtal counterpart of hæmoglobin *H* [13]; it consisted solely of γ-chains. It was not known how many of these chains combined to form the 'Bart's' hæmoglobin molecule. We have, therefore, examined the sedimentation-rate of a mixture containing 89 per cent hæmoglobin *A* (molecular weight approximately 68,000) and 11 per cent of hæmoglobin 'Bart's'. This was prepared from the blood of a patient kindly sent to us by Dr. B. Ramot of the Government Hospital, Tel-Hashomer, Israel. Pure hæmoglobin 'Bart's' was separated electrophoretically from this mixture on starch block and also examined.

Solutions of the carboxy proteins equilibrated by dialysis against phosphate–sodium chloride buffer *p*H 8·0, ionic strength 0·35 (potassium dihydrogen phosphate 0·0044 *M*, disodium hydrogen phosphate 0·0652 *M*, sodium chloride 0·15 *M*), were studied in the Svedberg oil-turbine ultracentrifuge at 54,000 rev./min., the diagonal schlieren system being used for optical observation.

The mixture of hæmoglobin *A* and hæmoglobin 'Bart's' sedimented as a single symmetrical peak when examined at concentrations of 1·5 and 1·0 gm. protein/100 ml. At the latter concentration the sedimentation coefficient was $S_{20,w} = 4{\cdot}13$ *S*. A solution of hæmoglobin 'Bart's' examined at 0·36 gm./100 ml. also sedimented as a single component, with $S_{20,w} = 4{\cdot}49$ *S*. These values for the sedimentation coefficients are in excellent agreement with those obtained at corresponding concentrations of carboxyhæmoglobin *A* by Kegeles and Gutter[14]. From these observations it may be concluded that the molecular weight of hæmoglobin 'Bart's' is very close to that of hæmoglobin *A*, approximately 68,000.

By analogy with Jones *et al.*[11], who have named hæmoglobin *H* β_4, we suggest that hæmoglobin 'Bart's' should be referred to as γ_4.

Fœtal hæmoglobin ($\alpha_2\gamma_2$) is distinguished by a 'tryptophan notch' in the ultra-violet spectrum and by being more resistant to denaturation by alkali than adult hæmoglobin ($\alpha_2\beta_2$). Hæmoglobin γ_4 shares these properties to a different degree. Choremis, Zannos-Mariolea, Ager and Lehmann[15] produced a figure in which the absorption spectra of solutions of equal strength of $\alpha_2\gamma_2$ and γ_4 are compared, and it can be seen that for γ_4 the 'tryptophan notch' is about twice that of $\alpha_2\gamma_2$. The alkali resistance of γ_4 is, however, only about one half that of $\alpha_2\gamma_2$. A possible explanation is that the distinctive ultra-violet spectrum is due to chemical properties of the γ-chain, but that the alkali resistance is associated with the structural arrangement of the four chains in the hæmoglobin molecule. The combination of α- and γ-chains would then produce a less-accessible target for the denaturing agent than that of γ-chains by themselves.

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[1] Perutz, M. F., Liquori, A. M., and Eirich, F., *Nature*, **167**, 929 (1951).
[2] Cullis, A. F., Dintzis, H. M., and Perutz, M. F., "Conference on Hemoglobin", Publication 557, Nat. Acad. Sci., 50 (Nat. Res. Council, Washington, D.C., 1958).
[3] Ingram, V. M., *Nature*, **178**, 792 (1956).
[4] Rhinesmith, H. S., Schroeder, W. A., and Pauling, L., *J. Amer. Chem. Soc.*, **79**, 4682 (1957).
[5] Rhinesmith, H. S., Schroeder, W. A., and Martin, N., *J. Amer. Chem. Soc.*, **80**, 3358 (1958).
[6] Schroeder, W. A., and Matsuda, G., *J. Amer. Chem. Soc.*, **80**, 1521 (1958).
[7] Porter, R. R., and Sanger, F., *Biochem. J.*, **42**, 287 (1948).
[8] Masri, M. S., and Singer, K., *Arch. Biochem. Biophys.*, **58**, 414 (1955).
[9] Hunt, J. A., *Nature*, **183**, 1373 (1959).
[10] Ingram, V. M., *Brit. Med. Bull.*, **15**, 27 (1959).
[11] Jones, R. T., Schroeder, W. A., Balog, J. E., and Vinograd, J. R., *J. Amer. Chem. Soc.*, **81**, 3161 (1959).
[12] Ager, J. A. M., and Lehmann, H., *Brit. Med. J.*, i, 929 (1958).
[13] Hunt, A. J., and Lehmann, H., *Nature*, **184**, 872 (1959).
[14] Kegeles, G., and Gutter, F. J., *J. Amer. Chem. Soc.*, **73**, 3770 (1951).
[15] Choremis, C., Zannos-Mariolea, L., Ager, J. A. M., and Lehmann, H., *Brit. Med. J.*, ii, 348 (1959).

RADIOBIOLOGY

Potentiation of Hair-Growth by Ultra-Violet Light

SINCE Findlay performed his pioneer experiments in 1928 [1], much research has been carried out to investigate the carcinogenic action of ultra-violet light on skin.

Little work has been done, however, to establish the exact wave-length of light concerned in the production of tumours, and it was in the course of experiments designed to elucidate this problem that a growth-promoting effect of ultra-violet light on hair was observed.

The apparatus used in this work was the monochromator described by Magnus *et al.*[2], which employs a large quartz, water-filled prism for dispersion and a 2-kW. high-pressure xenon arc lamp (Osram *XBO* 2001) as light-source. Male mice of strain *A*, aged 2–3 months, were used in the experiments.

The hair was removed from the flanks of a mouse with Clukes small animal clippers, and the animal was placed in a jacket of 'Cellophane' secured with Spencer Wells forceps. The jacket had an opening cut in the side to correspond with the exit slit of the monochromator, and was held in a clamp with this opening opposite the exit slit.

A series of six mice was exposed to ultra-violet light of wave-length 2600 Å. for a period of four weeks, irradiated five days per week, daily dose: $2{\cdot}5 \times 10^7$ ergs. cm.$^{-2}$.

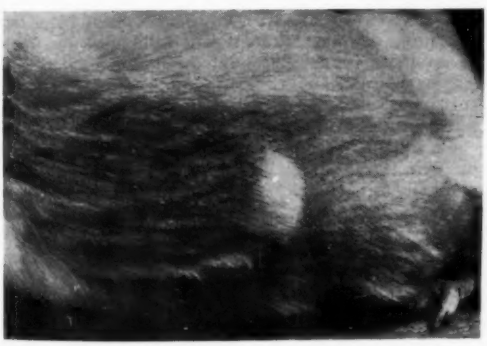

Fig. 1. Flank of mouse showing tuft of hair in irradiated patch

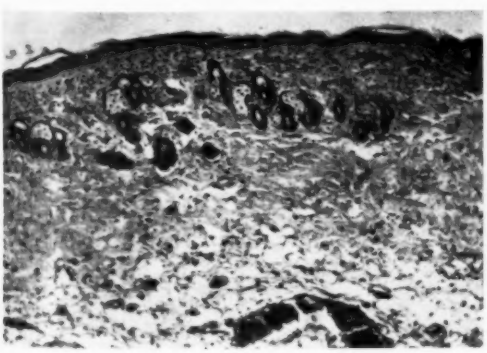

Fig. 2. Serial section from edge of the patch. Compare with the control

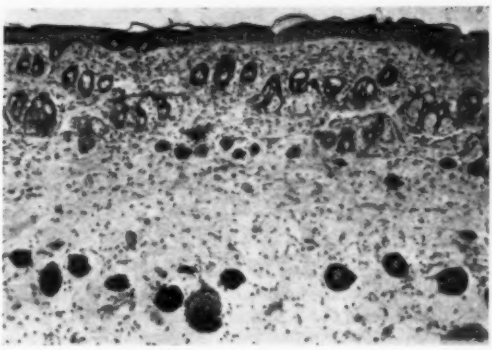

Fig. 3. Serial section from just inside the edge of the patch. The resting phase hair follicles are undisturbed, but activity can be observed in the dermis. The epidermis is characteristically thickened

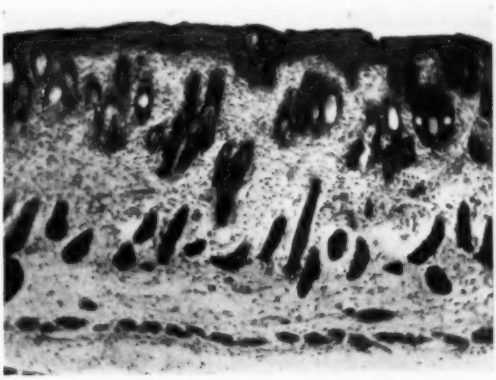

Fig. 4. Serial section from the centre of the patch. The active hair follicles are very evident, and the resting phase follicles are considerably disordered. The epidermis is extremely thickened in this region

In each specimen, a considerable potentiation of hair-growth was observed in the irradiated patch of skin.

As the hair growth-cycle was not at an identical stage in each specimen, the appearance of hair through the epidermis did not occur at the same time in each animal. There were, however, similar changes in the skin of each animal, and by the end of three weeks

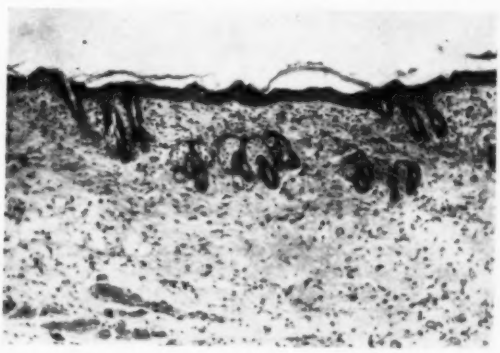

Fig. 5. Section from opposite flank as control. The hair growth-cycle is in its resting phase, the hair club and capsule lying in a position close to the epidermis, just below the level of the sebaceous gland duct

irradiation a definite tuft of hair was invariably apparent, while the surrounding skin was still bare from the original clipping (Fig. 1).

After two days exposure, the skin in the irradiated patch appeared flushed, showing a typical erythema reaction. This condition was maintained for varying lengths of time, but was always followed by the appearance of œdematous ridges at the edges of the patch. Hair was first observed growing between these ridges which eventually subsided, the skin then appearing quite normal with an oblong tuft of hair growing on it.

The tuft of hair was clipped down to the skin again in each case, three animals being further irradiated, and the other three being killed for a histological examination of the patches. Serial sections were cut across the patches from anterior to posterior, and were stained with Harris's hæmatoxylin and eosin. A gradient of follicle activity was observed from the outer edges of the patch, reaching a peak at the centre (Figs. 2–4). Control sections were also cut and stained (Fig. 5).

Work is now proceeding to study the further effects of irradiation at 2600 Å., and to determine the effects of other wave-lengths upon the growth of hair.

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[1] Findlay, G. M., *Lancet*, **2**, 1070 (1928).
[2] Magnus, I. A., Porter, A. D., McCree, K. J., Moreland. J. D., and Wright, W. D., *Brit. J. Derm.*, **71**, 261 (1959).

Polyvalent Immunological Tolerance in Homologous Radiation Chimæras

The 'secondary disease' of homologous radiation chimæras may be avoided by using embryonic hæmatopoietic cells for the therapy of lethally irradiated mice instead of corresponding cells derived from adult donors[1–3]. This fact seems to be indirect evidence that :

(1) The immunological capacity of the surviving animals is of donor specificity originating from the lymphoid cells present in the embryonic graft.

(2) The compatibility between the host and immunologically competent cells of the homograft which became mature in close contact with the host's antigens might be due to the immunological tolerance of the graft against its host.

If this hypothesis holds, attempts might be made to extend the immunological tolerance of the embryonic graft to more antigens than those specific for its lethally irradiated host only, with the eventual aim of converting the homologous radiation chimæras into universal recipients of homologous tissues from any randomly selected individual of an antigenically heterogeneous population. The same principle could be used here as in the experiments of Hašek and Hašková[4] on polyvalent immunological tolerance in ducklings : to expose immunologically immature cells to the complete antigenic spectrum representing the given population. In the treatment of lethally irradiated mice, these conditions could be accomplished by means of pooled embryonic hæmatopoietic cells derived from a sufficiently great number of donors.

A preliminary experiment was made to estimate the suitable number of donors[5]. It was assumed that this number must exceed the minimal number of embryonic donors the pooled cells of which need to be administered to normal recipients to render them capable of developing a second-set reaction against a skin homograft from any donor selected at random. It was demonstrated that 40 embryonic donors are necessary to induce a 'universal' transplantation immunity by means of their pooled cells. With 50 embryonic donors, therefore, the experiments were started to induce a 'universal' immunological tolerance in homologous radiation chimæras.

Adult female mice of a random-bred strain *H* were used. All 65 control skin homografts carried out between randomly selected individuals of this population were rejected during 23 days with a mean survival-time of 10·7 days. Irradiated animals (900 r. X-rays ; 220 kV., 22 m.amp., half-value layer 1·2 mm. copper, 27 r./min. at 70 cm.) have been given intravenously 0·5 ml. of embryonic liver cell suspension containing 10^7 cells per mouse. The survivors were skin grafted approximately 2 months later with the results shown in Table 1.

From the results presented here, it seems to be evident that :

(1) Even if the skin grafts originate from the same individual or from the same inbred strain as the therapeutic dose of embryonic hæmatopoietic cells, a low proportion of them fails to survive, probably because of the recovering immunological capacity of the host.

(2) No grafts survive from donors other than those of the therapeutic dose of hæmatopoietic cells with the exception of cases when pooled embryonic cells from 50 donors were administered.

(3) The mean survival-time of the rejected grafts seems to be slightly prolonged in homologous radiation chimæras in comparison with that in non-irradiated recipients of the same population.

Table 1. Effect of Therapeutic Procedure in Lethally Irradiated Random-bred *H*-Mice on the Results of Skin Grafting

Group	Donor of the embryonic liver cells	Donor of the skin graft	Successful grafts (intact after 2 months)	Mean survival-time of the rejected grafts (days)	
				In radiation chimæras	In control non-irradiated *H*-mice
1	Inbred *CBA* embryos 18–19-day old	*CBA*	17/20	17·0	9·7
		C 57 BL	0/5	12·0	9·2
2	Random-bred *H* embryos 18–19-day old	*H*-donor of the embryonic liver cells (embryonic skin frozen with glycerol)	8/10	17·0	11·0
	Not pooled cells—one embryonic donor for one recipient	Randomly selected adult *H*	0/8	15·3	10·7
3	Random-bred *H* embryos 18–19-day old, pooled cells from fifty donors	Randomly selected adult *H*	5/9	17·0	10·7

(4) Immunological tolerance may be induced in the pooled embryonic inoculum leading to the compatibility not only between graft and host but also among the individual components of the graft itself. Immunological competition among pooled inoculum of adult bone marrow cells seems to account for the failure in the attempt of Murray *et al.*[6] to enhance the transplantability in lethally irradiated rabbits. This would be also in agreement with the finding of Billingham *et al.*[7] and Gorer[8].

(5) It might be useful to increase the number of embryonic donors to more than 50. As the number of the donors is raised, the antigenic contribution from each of them decreases on one hand, but on the other the probability increases of a given antigen occurring several times in the pool.

(6) With regard to antigenic heterogeneity, both the mouse population as described here and the duck population of Hašek and Hašková seem to resemble the wild population much more closely than the random-bred rats used in experiments of Billingham and Silvers[9]; the induction of a state of 'polyvalent' immunological tolerance by means of a pool of immunologically immature cells comprising the complete antigenic spectrum of a wild population need not, therefore, be beyond practical possibilities.

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[1] Lengerová, A., Conf. on Biological Basis of Tissue Transplantation (Prague, 1957); *Trans. Bull.*, **5**, 69 (1958).
[2] Barnes, D. W. H., Ilbery, P. L. T., and Loutit, J. F., *Nature*, **181**, 488 (1958).
[3] Uphoff, D. E., *J. Nat. Cancer Inst.*, **20**, 625 (1958).
[4] Hašek, M., and Hašková, V., Conf. on Biological Basis of Tissue Transplantation (Prague, 1957); *Trans. Bull.*, **5**, 69 (1958).
[5] Lengerová, A., and Chutná, J., *Folia Biol.* (Prague), **6**, 50 (1960).
[6] Murray, J. E., Wilson, R. E., Dealy, J. B., Sadowsky, N. L., and Corson, J. M., "Biological Problems of Grafting", 354 (Liège, 1959).
[7] Billingham, R. E., and Brent, L., *Phil. Trans. Roy. Soc.*, B, **242**, 439 (1959).
[8] Gorer, P. A., "Biological Problems of Grafting", 366 (Liège, 1959).
[9] Billingham, R. E., and Silvers, W. K., *J. Immunol.*, **83**, 667 (1959).

BIOLOGY

Mutations affecting the Density of Bacteriophage λ

IT has been shown by Weigle, Meselson and Paigen[1] that λ-phage particles able to transduce galactose markers have buoyant densities in cæsium chloride which differ from that of the phage from which they were derived. The altered densities are transmitted to the offspring.

Weigle *et al.*[1] showed that spontaneous clear (*c*) mutants derived from λ reference[2] are not altered in density. They did find, however, that the phages liberated, after induction, by a certain strain of bacteria lysogenic for λ were denser than λ reference.

While studying the densities of the λ mutants used by Jacob and Wollman[3] and by Kaiser[4] we found phages of two other densities. The buoyant densities in cæsium chloride of plaque-forming λ are given in Table 1.

Table 1

Phage	Buoyant density symbol	Buoyant density in CsCl (gm./cm.³)	Origin of the phages
λref	*B*0	1·508	Kaiser (ref. 2)
λdense	*B*1	1·512	Weigle *et al.* (ref. 1)
λco	*B*2	1·491	Jacob and Wollman (ref. 3)
λ*c mi*	*B*2	1·491	and Kaiser (ref. 2)
λ*c m*6	*B*2	1·491	
λ*ch*	*B*3	1·504	Appleyard *et al.* (ref. 4)
λ*m*5	*B*3	1·504	Jacob and Wollman (ref. 3)

The densities were measured using the density of λ reference as density reference (see Weigle *et al.*[1]) in a Spinco analytical ultracentrifuge by the method of density gradient of Meselson, Stahl and Vinograd[5].

Phages of the density *B*2 were chosen for a detailed genetic study. These phages carrying the markers *c mi* or *c m*6 were crossed to λ reference (and later to λ*m*5) of density *B*0. The progeny phages of these crosses were analysed by density gradient centrifugation. The phages, suspended in cæsium chloride solution in water, are placed in 'Lusteroid' tubes in the *SW* 39 swinging bucket rotor of a Spinco ultracentrifuge and spun for 16 hr. at 22,000 r.p.m. Then as described by Weigle *et al.*[1] the bottoms of the tubes are pierced and successive emerging drops are collected separately. The contents of each drop are later analysed for the number of phages and for the genetic markers these carry.

The results show that virtually all the progeny phages have the densities *B*0 and *B*2 of either of the parents (about 0·1 per cent of the progeny phage which seem to have an intermediate density are at present under study). All the phages of density *B*0 or *B*2 respectively transmit this density to their progeny regardless of the genetic markers they carry. Recombinant phages of density *B*2 when crossed with one another give progeny only of the density *B*2 (and this is true of recombinants of density *B*0 also). Density *B*2 thus behaves as a single genetic character. We shall call *b*2 this character and *b*2⁺ its allele in λ reference. By comparing the relative frequencies of different genetic markers at the densities *B*0 and *B*2 respectively it is possible to locate *b*2 on the genetic map of λ. It is very near *m*5. In fact in a cross between λ*m*5 *b*2⁺ and λ*m*5⁺ *b*2 only about 0·01 per cent recombinants λ*m*5⁺*b*2⁺ and λ*m*5*b*2 are observed.

In a cross between *b*2 and *b*2⁺ the phenotype *B*2 or *B*2⁺ (or *B*0) respectively always corresponds to the genotype *b*2 or *b*2⁺, that is, there is no phenotypic mixing.

The phages *b*2⁺ are able to mutate to *b*2, but reverse mutations have not been looked for.

The phages *b*2 are different from *b*2⁺ not only in density but also in their ability to form stable lysogens. In all the cases studied the decrease in density was always accompanied by loss in the ability to form stable lysogens. The marker *b*2 is perhaps identical to the marker *l* of Jacob and Wollman[3] which they located near *m*5 and which also prevents stable lysogenization.

The density *B*1 seems also to be determined by a locus *b*1, located in the *c* region of the genetic map of λ. The presence of *b*1 increases the density of λ without affecting its lysogenizing frequency.

We have been unable to study quantitatively the properties of the phages of density *B*3, for the phages

of this phenotype are unstable. Stocks of λ*B*3 become partially inactivated in the course of time and in lytic cycles of growth there is a strong selection in favour of phages of the phenotype *B*3⁺ which may appear as a consequence of mutations. Phages λ*B*3 can be osmotically shocked by choline hydrochloride (according to a method devised by S. Brenner (private communication)). Phenotypic mixing occurs in crosses of λ*B*3 by λ*B*3⁺. The frequency of lysogenization of λ*B*3 is equal to that of λ reference.

The causes of the changes in densities are at present unknown. To give an idea of the magnitudes involved in these variations, it may be calculated (see Weigle *et al.*[1]) that if *B*2 was due only to an alteration of its deoxyribonucleic acid content λ*b*2 would possess only 83 per cent of the deoxyribonucleic acid content of λ*b*2⁺.

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[1] Weigle, J., Meselson, M., and Paigen, K., *J. Mol. Biol.*, **1**, 379 (1959).
[2] Kaiser, A. D., *Virology*, **1**, 424 (1955).
[3] Jacob, F., and Wollman, E., *Ann. Inst. Pasteur*, **87**, 653 (1954).
[4] Appleyard, R. K., McGregor, J. F., and Baird, K. M., *Virology*, **2**, 565 (1956).
[5] Meselson, M., Stahl, F., and Vinograd, J., *Proc. U.S. Nat. Acad. Sci.*, **43**, 581 (1957).

Combined Oil-immersion, Phase-contrast, and Dark-ground Viewing of 'Thorotrast' in Tissue Sections

'Thorotrast' (colloidal thorium dioxide) can be identified quite easily in tissue sections when using an ordinary light microscope, provided that it is present in sufficient quantity. Under such conditions 'Thorotrast' is seen as characteristic refringent brownish clumps.

Small quantities of 'Thorotrast', however, especially when ingested by phagocytes or other cells, or lying intermingled with pigment cells, are often difficult to see.

A method of using a phase-contrast microscope of any standard pattern (providing it is fitted with annuli and circular stops in the phase-plate) has been found which enables the exact distribution of 'Thorotrast' in tissue-sections, in either large or small quantities, to be ascertained.

The microscope is set up, the light centred in the usual way, and the phase-system adjusted for phase-oil-immersion viewing, using the ×95 phase-plate stop. The 2/3 in. (× 10), or other low-powered objective in the ×20 to ×40 range is now substituted for the higher-power objective, but using the ×95 stop as before.

The result, which is a partial dark-ground illumination, shows the 'Thorotrast' as brightly illuminated particles in a nearly dark-ground field ; but the position of the particles within the tissues can still be made out, which is not the case when using a conventional dark-ground condenser.

If the sub-stage condenser is now moved up and down, a whole range of contrasting illuminations is obtained from near dark-ground, through a spectral series of contrasting colours in both specimen and background, to white illumination when a stained preparation appears as seen under an ordinary light microscope. For photographic purposes the differential effect may be increased by the use of appropriate colour-filters.

The effects just described are not seen when a fresh sample of 'Thorotrast' is examined, but only after it has been incorporated into body tissues. These effects may also be observed, though in a lesser degree, when using a continuously variable phase-contrast microscope. Such instruments, however, are less common than standard phase-contrast equipment.

The method may also be used with advantage for the examination of living cells, stained, and unstained sections ; especially it has been found useful for rapid preliminary inspection of such objects as tissue explants, cultures of protozoa and similar living objects. Finally, the method allows rapid change over to oil-immersion, with or without phase-contrast, since the ×95 stop remains centred throughout.

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Ageing of Mitochondria

The ability of ethylenediamine tetraacetic acid to stabilize mitochondria is well known[1–6]. The present work was concerned with the effect of ethylenediamine tetraacetic acid on mitochondria in 0·25 *M* sucrose during and after rigorous treatment either by pre-incubation with carbon tetrachloride or by standing at 22° C. and then at 0° C. for prolonged periods.

Christie and Judah[7] found that washed mitochondria isolated from liver homogenates which had been pre-incubated at 0° C. for 3–4 hr. with carbon tetrachloride oxidized certain substrates at very low rates. The oxidations affected were those catalysed by enzyme systems which require pyridine nucleotides for electron transport. Normal activities could be restored by the addition of co-factors containing the appropriate pyridine nucleotide.

In the present work 10 per cent w/v homogenates of rat liver were prepared at 0–1° C. in 0·25 *M* sucrose, and in 0·25 *M* sucrose + 0·001 *M* ethylenediamine tetraacetic acid. Carbon tetrachloride was added to a concentration of 0·03 *M*, and mixed with the homogenate by shaking. Mitochondria were isolated immediately from portions of the homogenates by differential centrifuging[8]. They were then re-suspended in 0·25 *M* sucrose to wash off residual carbon tetrachloride, re-centrifuged and re-suspended in 0·25 *M* sucrose. The remaining portions of the homogenates were shaken gently at 0–1° C. for 90 min. in contact with carbon tetrachloride ; mitochondria were then isolated, washed and re-suspended in 0·25 *M* sucrose.

Mitochondria from homogenates treated with carbon tetrachloride for 90 min. were found to have lost much of their ability to oxidize citrate (Table 1). Normal rates of citrate oxidation were restored by adding 0·0005 *M* diphosphopyridine nucleotide, 0·00067 *M* glutathione and 0·04 nicotinamide to the

Table 1. Effect on Ageing of Mitochondria of Ethylenediamine Tetraacetic Acid (EDTA) in Homogenate
Procedure: described in text. Results shown are the ranges and means of three experiments, each in duplicate

Homogenate medium	Oxygen uptake (μl./30 min./0·6 mgm. enzyme nitrogen)					
	Time 0		Time 0 + 90 min.		Time 0 + 210 min.	
	Range	Mean	Range	Mean	Range	Mean
Sucrose 0·25 *M* + CCl_4 0·03 *M*	71–96	84	25–43	36	—	—
Sucrose 0·25 *M* + CCl_4 0·03 *M* + EDTA 0·001 *M*	89–119	108	79–117	87	—	—
Sucrose 0·25 *M*	94–112	101	—	—	29–41	34
Sucrose 0·25 *M* + EDTA 0·001 *M*	87–114	104	—	—	70–95	81

System: adenosine-5-monophosphate 0·001 *M*; magnesium sulphate 0·0067 *M*; potassium chloride 0·025 *M*; inorganic orthophosphate buffer, *p*H 7·4, 0·013 *M*; cytochrome *c* 0·00001 *M*; sodium citrate 0·01 *M*; 0·5 ml. 20 per cent (w/v fresh liver) mitochondria in 0·25 *M* sucrose; water to 3 ml. final volume; 0·1 ml. 20 per cent potassium hydroxide in centre well to absorb carbon dioxide; gas phase air; temperature 38° C.

reaction mixture. However, Table 1 shows that the presence of 0·001 *M* ethylenediamine tetraacetic acid in homogenates reduced considerably the fall in citrate oxidation.

Similarly, ethylenediamine tetraacetic acid was found to protect mitochondria in liver homogenates subjected to severe ageing at 22° C. and 0° C. In order to accelerate ageing, 10 per cent liver homogenates were stood for 30 min. at 22° C. during which time the homogenate temperature rose to 16·5° C., and then for a further 180 min. at 0–1° C. Table 1 shows that although such treatment in 0·25 *M* sucrose homogenates greatly impaired the ability of mitochondria to oxidize citrate, mitochondria from 0·25 *M* sucrose + 0·001 *M* ethylenediamine tetraacetic acid homogenates gave normal rates of oxidation. The protective effect of ethylenediamine tetraacetic acid was demonstrable whether or not additional ethylenediamine tetraacetic acid was added to the respiratory reaction mixture.

Surprisingly, the capacity of mitochondria, aged by either of the above ageing procedures, to oxidize citrate was maintained or restored by the addition of 0·001 *M* ethylenediamine tetraacetic acid only to the system used to measure citrate oxidation (Table 2).

Mitochondria aged by standing or by carbon tetrachloride lose the sensitivity of adenosine triphosphatase to activation by calcium ions and 2 : 4-dinitrophenol, and they become fully sensitive to activation by magnesium ions[9–12]. It has been implied that the change in adenosine triphosphatase response might be related in some way to the loss of mitochondrial pyridine nucleotides and the inactivation of dependent enzyme systems[11–13]. However, in the present work, the omission of magnesium from the respiratory medium and the addition of 0·01 *M* sodium fluoride, which removes further magnesium ions with or without the addition of 0·001 *M* adenosine triphosphate, did not prevent the fall in citrate oxidation rates subsequent to either ageing treatment. Siekevitz *et al.*[10] have shown that adenosine triphosphatase of aged mitochondria is activated largely by bound magnesium ions or by bound magnesium ions plus magnesium–ethylenediamine tetraacetic acid, and that the addition of 0·005 *M* ethylenediamine tetraacetic acid did not greatly inhibit the adenosine triphosphatase activity of fresh or aged mitochondria. Consequently the stabilizing effect of ethylenediamine tetraacetic acid against the loss of activity of pyridine nucleotide-dependent enzyme systems of aged mitochondria would appear to be by some mechanism other than inhibition of adenosine triphosphatase.

Table 2. Effect of Ethylenediamine Tetraacetic Acid on Mitochondria Isolated from Aged Homogenates
Procedure: described in text. Results shown are the means of four experiments all of which gave good agreement for equivalent readings

Homogenate medium	Additions	Oxygen uptake (μl./30 min./0·6 mgm. enzyme nitrogen)		
		Time 0	Time 0 + 90 min.	Time 0 + 210 min.
Sucrose 0·25 *M*	None	88	69	33
Sucrose 0·25 *M*	EDTA 0·001 *M*	89	82	71
Sucrose 0·25 *M* + CCl_4 0·03 *M*	None	87	—	40
Sucrose 0·25 *M* + CCl_4 0·03 *M*	EDTA 0·001 *M*	93	—	79

System: as in Table 1.

It appears that prolonged standing in 0·25 *M* sucrose or pre-incubation with carbon tetrachloride does not lead to direct passive diffusion of pyridine nucleotides from mitochondria. Such treatment must, however, alter the mitochondria in such a way as to permit the operation of a secondary change occurring after the commencement of incubation at 38° C. in the respiratory medium and leading to the loss of pyridine nucleotides and inactivation of dependent enzyme systems. Ethylenediamine tetraacetic acid prevents this secondary change. It may also prevent the primary damage by these ageing procedures as it is unnecessary to add ethylenediamine tetraacetic acid to the respiratory medium in order to maintain normal rates of citrate oxidation by mitochondria aged in 0·25 *M* sucrose + 0·001 *M* ethylenediamine tetraacetic acid. However, it is possible that sufficient ethylenediamine tetraacetic acid is taken up by mitochondria during ageing to prevent an ethylenediamine tetraacetic acid-sensitive reaction from occurring when the isolated mitochondria are incubated.

Accumulation of calcium ions from the homogenate during ageing might lead to further damage when mitochondria are incubated at 38° C. and to the loss of pyridine nucleotides[14]. However, measurement of the calcium content of trichloracetic acid extracts of mitochondria by the ethylenediamine tetraacetic acid–calcon method[15] showed that the concentration fell from 30–35 μgm. to 16–18 μgm./gm. wet liver during 5 hr. standing in a 0·25 *M* sucrose homogenate at 0–1° C. Therefore it is unlikely that the effect of ethylenediamine tetraacetic acid is associated with chelation of calcium ions.

Hunter *et al.*[16] have discussed the influence of various factors on the re-incorporation of dinitropyridine nucleotide into mitochondrial enzyme systems, and suggest that the effect of ethylenediamine tetraacetic acid is likely to be due to complexing with the mitochondrial membrane rather than to chelating metal ions. The results of the present work favour such an interpretation. Ethylenediamine tetraacetic acid would appear to prevent the loss of pyridine nucleotides from incubated, respiring, aged mitochondria either by acting at the mitochondrial membrane to maintain its semi-permeable character or by inhibiting the release of bound pyridine nucleotides from mitochondrial enzyme systems. It is possible that ethylenediamine tetraacetic acid exerts its influence by complexing with structural cations and altering the charge on the mitochondrial membrane or at the site of binding of pyridine nucleotides.

I wish to thank Miss Theda Flint-Gallé and Mr. R. A. Simmonds for technical assistance.

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[1] Cleland, K. W., *Nature*, **170**, 497 (1952).
[2] Slater, E. C., and Cleland, K. W., *Nature*, **170**, 118 (1952).
[3] Raaflaub, J., *Helv. Chim. Acta*, **38**, 27 (1955).
[4] Hunter, F. E., and Ford, L., *J. Biol. Chem.*, **216**, 357 (1955).
[5] Von Korff, R. W., *Science*, **126**, 308 (1957).
[6] Lester, R. L., and Hatefy, Y., *Biochim. Biophys. Acta*, **29**, 103 (1958).
[7] Christie, G. S., and Judah, J. D., *Proc. Roy. Soc.*, B, **142**, 241 (1954).
[8] Schneider, W. C., *J. Biol. Chem.*, **176**, 259 (1948).
[9] Potter, V. R., Siekevitz, P., and Simonson, H. C., *J. Biol. Chem.*, **205**, 893 (1953).
[10] Siekevitz, P., Löw, H., Ernster, L., and Lindberg, O., *Biochim. Biophys. Acta*, **29**, 378 (1958).
[11] Recknagel, R. O., and Anthony, D. D., *Fed. Proc.*, **16**, 105 (1957).
[12] Recknagel, R. O., and Anthony, D. D., *J. Biol. Chem.*, **234**, 1052 (1959).
[13] Siekevitz, P., and Potter, V. R., *Fed. Proc.*, **12**, 267 (1953).
[14] Potter, V. R., "Manometric Techniques", third ed., edit. by Umbreit, W. W., *et al.*, 175 (Burgess Publishing Co., Minneapolis, 1957).
[15] Golby, R. L., Hildebrand, G. P., and Reilley, C. N., *J. Lab. Clin. Med.*, **50**, 498 (1957).
[16] Hunter, F. E., Malison, R., Bridgers, W. F., Schutz, B., and Atchison, A., *J. Biol. Chem.*, **234**, 693 (1959).

Marked Humpback Whale of Known Age

The determination of age in humpback whales has been by indirect methods using baleen plates and ear plugs. By these methods, I found that humpback whales in Australian waters reach puberty between 3 and 7 years of age, the majority of puberal whales being 4 or 5 years[1]. Nishiwaki[2], using the ear plugs from humpback whales taken in North Pacific waters, found that the average age at sexual maturity was 5 years.

Until recently it has not been possible to check these results by direct evidence from marked whales. Dawbin[3] obtained some evidence from two humpback whales marked in New Zealand waters when at least 1 year old and recaptured after 12 and 19 months respectively. Since both were sexually immature when killed, Dawbin showed that the minimum age at sexual maturity was 3–4 years. Ear plugs and baleen plates were collected from one of these whales, and the present methods of interpretation of these organs for age determination gave results consistent with the probable age of this individual.

Further information is now available from a humpback whale marked (Mark No. 11689) on October 6, 1954, at 27° S. 153½° E., when it was migrating southwards on the east coast of Australia. It was then recorded as a yearling approximately 30 ft. in length. This mark was recovered on August 26, 1959, from a male humpback shot at 25° 21′ S. 112° 26′ E. off the west coast of Australia.

As ear plugs, baleen plates, and testis weights were obtained from this specimen, it has been possible to compare the age estimated from these organs with the known minimum age. Following the method of interpretation of baleen traces described by me[4], the age of this whale was determined as at least 5 years. The ear plugs contained 12 laminations, and, using the postulate of two laminations per year, the age of this whale was estimated at 6 years. Since the whale was at least at the beginning of its second year when marked, it was probably 6 years of age when shot. So the indirect methods using baleen plate traces and ear plug laminations give estimates of age in good agreement with the known age.

The testes each weighed 1·0 kgm., which indicates[5] that this whale was sexually immature, and that puberty would probably have been attained at 7 years of age. This is above the age at which most male humpbacks have been estimated to reach puberty; but it is not an isolated example since, of 118 males (from the west coast of Australia) the ear plugs of which contained 12 laminations, 6 per cent were still sexually immature.

The body-length of this whale was recorded as 36 ft. 9 in., which is relatively short for a male of 6 years but within the range of lengths recorded for males of that age. In 164 males from Australian whaling stations estimated on the evidence from ear plugs to be 6 years old, the body-lengths ranged from 34 ft. 7 in. to 43 ft. 3 in. with a mean length of 39·11 ft., standard deviation 1·62 ft., and a standard error of mean 0·13 ft. It is therefore probable that this was a slow-growing individual relatively late in maturing.

The recovery of this mark is also of interest because it is the first recovery on the west coast of a mark fired into a whale on the east coast of Australia. This change of migration path followed the mingling during the summer of 1958–59 of some of the group V (130° E.–170° W.) with the group IV (70° E.–130° E.) dopulation of humpback whales which I[4] have shown in the region of the Antarctic from 110° E. to 130° E.

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[1] Chittleborough, R. G., *Aust. J. Mar. Fresh. Res.*, **10**, 125 (1959).
[2] Nishiwaki, M., *Sci. Rep. Whales Res. Inst. Tokyo*, **14**, 49 (1959).
[3] Dawbin, W. H., *Nature*, **183**, 1749 (1959).
[4] Chittleborough, R. G., *Norske Hvalfangsttid*, **48**, 510 (1959).
[5] Chittleborough, R. G., *Aust. J. Mar. Freshw. Res.*, **6**, 1 (1955).

Morphogenetics of *Micrasterias americana* in Clone Culture

Waris, Grönblad and I have studied the plasmatic basis of the morphological units in *Micrasterias* species and their dependence on the nuclear influence[1]. The names of the morphological units and the schematically drawn plasmatic axes are shown in Fig. 1. The form, as well as the number, of the morphological units may be altered by a change in environmental conditions and by a change in the relative nuclear influence.

The concept 'nuclear effect per cytoplasmic unit' is of importance when variation in the morphology of the cell is considered. The variation can be induced artificially in different cell types (anucleate, hypohaploid, haploid, hyperhaploid, subdiploid and diploid cell types; binucleate cells of different types, mononucleate double cells; uniradiate, triradiate and quadriradiate types). The degree of organization of the side lobes usually increases in parallel with an increase in nuclear quantity; but the polar lobe usually undergoes only slight modification.

Also the number of morphological units may increase with the nuclear quantity, whereupon

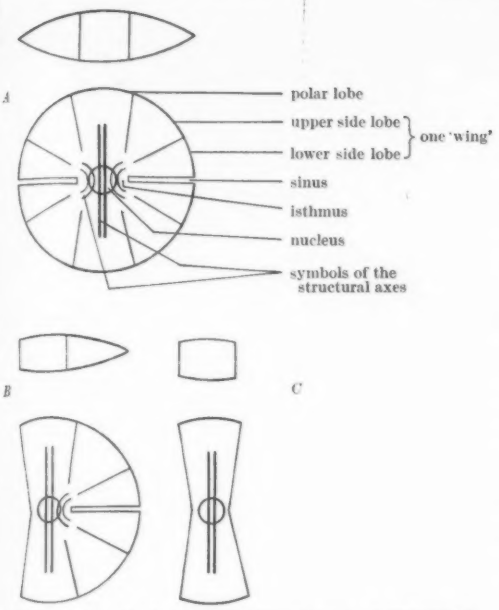

Fig. 1. Schematic drawings of different types of *Micrasterias*. *A*, Normal biradiate cell from the end and from the front; *B*, uniradiate cell; *C*, radiate cell

triradiate and quadriradiate forms are produced from the normal biradiate form. Such forms are found in Nature[2] and can be produced artificially from some *Micrasterias* species (*M. thomasiana*, *M. rotata*, *M. torreyi*, *M. angulosa*). The triradiate and quadriradiate forms of *Micrasterias* species are always diploid forms.

Since 1939 we have had under cultivation a clone of *Micrasterias thomasiana* var. *notata* which was produced spontaneously and in which one of the wings is absent from the cells. These cells are uniradiate forms. Since then, uniradiate forms of the species *M. torreyi*, *M. rotata* var. *evoluta*, *M. thomasiana* and *M. americana* have been discovered. An analogous form was also produced from *M. fimbriata*; but the clone died before it could be investigated in detail.

The significance of the nuclear effect per cytoplasmic unit is clearly seen in this haploid uniradiate cell. Morphological analysis has revealed that the existing morphological units in the uniradiate cell resemble the units in diploid cells in both size and form as a result of nearly equal ratio between nuclear quantity and cytoplasmic units in these two types of cells.

Because the number of cytoplasmic units was seen to increase with the nuclear quantity, the hypothesis was suggested that conversely a decrease in the nuclear influence (per cytoplasmic unit) may lead to the elimination of a cytoplasmic unit. This was later demonstrated in the case of *M. torreyi* double cells, which are cells that, owing to abnormal cytokinesis, contain the plasma of more than one haploid cell and a varying number of nuclei (one haploid, one diploid nucleus, or two haploid nuclei in different sites in the cell). These experiments revealed an effect of subnormal nuclear influence in accordance with the hypothesis, and clarified in principle the process by which uniradiate cells are produced.

A uniradiate cell may 'remutate' into a normal biradiate form. This is the same process that occurs when a biradiate cell becomes transformed into a triradiate cell by an increase in the number of side lobe units. The question then arose whether a cell with new side lobe units could be produced, and whether such a cell consisting of only polar lobe units is capable of existence. The method employed to produce the cell with no side lobe unit was in principle the same as that used to produce uniradiate cells: some of the plasmatic units in double and other complex cells may lose their ability of reproduction, but the cell may still be capable of continuing its existence.

The organisms studied in the present investigation were uniradiate cells of *M. thomasiana* and *M. americana*. The desired result was obtained with the latter species. Numerous double cells of different types were produced in old cultures exposed to continued illumination. From one of such culture tubes with different types of abnormal cells, cells which lacked both side lobe units were produced spontaneously.

The new cell type, here called the aradiate type, is depicted in Fig. 2. This cell type scarcely resembles the genus *Micrasterias*. Perhaps the genus *Ichtyodontum* recently described by Scott and Prescott exhibits similar main features.

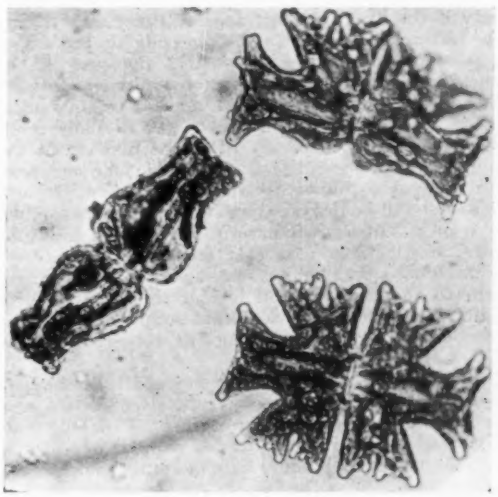

Fig. 2. *Micrasterias americana*. Biradiate, uniradiate and aradiate cell grown in the same culture tube

The aradiate *Micrasterias americana* cell thus has only one of the three morphological components of the normal biradiate *Micrasterias* cell. The following differences were noted when the aradiate cells were compared with normal *M. americana* cells growing in the same culture tube and hence under identical conditions. The aradiate cell is longer than the biradiate haploid cell. The apex of the former cell differs in form from that of the polar lobes of the latter in that the processes are always less well developed. When seen in end-view the cross-section of the aradiate cell is round except the apex which is usually irregular and sometimes forms an equilateral triangle.

The aradiate form has not been observed to undergo remutation to a uniradiate or biradiate form,

although the total number of divisions that has occurred to date exceed one thousand. Under the same conditions the 'remutation' frequency in a uniradiate control cell clone has been about twenty for every thousand divisions.

On the basis of the earlier conclusions and the study of the aradiate *M. americana* cells, the mechanism of the morphological development of a *Micrasterias* cell may be described roughly as follows.

There are in a normal *Micrasterias* cell three plasmatic axes or skeletal units that extend from one end of the cell to the other. In every cell division these units are severed in the plane of division at the isthmus of the cell. After the septum has formed, the semi-axes begin to grow and generate the lacking halves of the axes. The parent and full-grown daughter semi-axes are symmetrically located about the plane passing through the isthmus of the cell. The present nuclear influence per cytoplasmic units determines the shape (the complexity) of the morphological units, but not their existence or non-existence. Also when non-nucleate cells are formed after the nucleus is removed during mitosis, three undifferentiated lobes are seen in the new semi-cell, when the parent semi-cell is biradiate, only two when the parent semi-cell is uniradiate and four when the parent semi-cell is triradiate.

Normal regeneration of the semi-axes is possible only if the axes have attained full maturity during the interphase period. This metabolic process is dependent on the influence of the nucleus. If the nuclear effect is weak, the various units compete for the metabolic components of nuclear origin and it may happen that only one of the two side lobe semi-axes is able to regenerate after the division of the cell. Hence if one of the plasmatic side lobe semi-axes is not capable of autocatalytic reproduction, the new semi-cell will be defective and lack the corresponding lobe unit. In the aradiate cell type both side lobe axes are lacking. In this connexion it may be pointed out that a similar metabolic competition may lead to the resorption of one of the two nuclei in binucleate cells owing to a scant supply of metabolic component of plasmatic origin required in the development of the nuclei.

If the nuclear effect is strong enough, it may happen that one of the semi-axes branches and two new semi-axes are produced by it instead of only one. This leads to an increase in the number of wings as in 'remutation' of a uniradiate cell into a normal cell or the mutation of the biradiate cell into a triradiate cell after ploidization.

The plasmatic polar and side lobe units obviously differ in nature. Side lobe semi-axes are able to generate only side lobe semi-axes and the polar lobe semi-axes only their like. Owing to the fact that the aradiate cell type has no side lobes, it cannot be expected to remutate into winged forms by producing new side lobes.

The lobes may exert an influence on morphology of the adjoining lobes. The apex of the polar lobe of uniradiate cells (in different species) is often asymmetrical when viewed from the front. The polar lobe of the aradiate form which has no side lobes has a higher degree of symmetry than the polar lobe of the normal cell. The outer ends of the polar lobes of triradiate diploid cells of *M. torreyi* often are equilateral triangles when seen in end view. The morphology of the polar lobe reflects the existence or non-existence of side lobes.

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[1] Kallio, P., *Arch. Soc. Zool.-Bot. Fenn. Vanamo*, **2**, 42 (1949). Waris, H., *Physiologia Plantarum*, **3**, 236 (1950); **4**, 387 (1951). Kallio, P., *Ann. Botanici Soc. Zool.-Bot. Fenn Vanamo*, **24**, 2, 1 (1951); *Bull. Torr. Bot. Club*, **80**, 4, 247 (1953); *Arch. Soc. Zool.-Bot. Fenn. Vanamo*, **8**, 1, 57 (1953); **2**, 118 (1954); **11**, 2, 193 (1957). Grönblad, R., and Kallio, P., *Botaniska notiser*, **2**, 167 (1954). Waris, H., *Ann. Acad. Sci. Fenn.*, A, IV, **40**, 1 (1958). Waris, H., and Kallio, P., *Ann. Acad. Sci. Fenn.*, A, IV, **37**, 1 (1957). Kallio, P., *Ann. Acad. Sci. Fenn.*, A, IV, **44**, 1 (1959).

[2] Heimans, J., *Blumea*, Supp. II, 52 (1942).

Nonanal as a Growth Factor for Wood-rotting Fungi

Some years ago Suolahti[1] found that volatile substances evaporating from wood of various trees strongly promoted the growth of several wood-destroying Hymenomycetes. In particular, the development of aerial mycelium was favoured. The effect seemed to be correlated with the presence of oleic acid and other unsaturated fatty acids in the wood. The active substance or substances could not be identified.

Since nonanoic acid (pelargonic acid) and nonanal (pelargonic aldehyde) are known to be formed during autoxidation of oleic acid[2], it appeared desirable to test these two nine-carbon compounds for growth-promoting activity.

The compounds were administered to the fungi either through the liquid phase or through the gas phase. In both cases two media were tested: a synthetic mineral–salt–glucose medium (modified medium 3, ref. 3) and a water solution of 5 per cent malt extract. The following species of wood-destroying fungi were studied: *Stereum sanguinolentum* Fr., *Daedalea unicolor* Bull. ex Fr., *Polyporus cervinus* Pers. and *P. applanatus* Pers. ex Wallr.

In the first type of experiment, where water solutions of the substances to be tested were pipetted into the liquid nutrient medium, nonanal was found to produce a strong promotion of growth in *Stereum sanguinolentum* (Table 1), whereas the other species showed a weak or no response. Nonanoic acid had no effect in all cases. The response of *Stereum* was stronger in the synthetic medium than in the malt extract medium, and could already be observed after one day. In the latter medium the increase in weight seemed to be due mainly to the more abundant production of aerial hyphæ in the flasks with nonanal.

Because of its volatility, nonanal rapidly disappears from the medium. Therefore, in prolonged experiments further addition of nonanal solution was made

Table 1. Growth of *Stereum sanguinolentum* in Liquid Culture with and without Nonanal

Nutrient solution	Dry weight of mycelium (mgm. per flask)		
	After 19 days	After 25 days	After 30 days
Synthetic medium (control)	0·9 ± 0	1·3 ± 0·1	1·9 ± 0·2
D : o + nonanal	5·9 ± 0·3	9·3 ± 1·5	12·7 ± 0·8
Malt extract (control)	32·0 ± 1·3	38·7 ± 0·9	42·7 ± 3·1
D : o + nonanal	42·8 ± 1·2	53·1 ± 2·1	58·2 ± 1·6

Each culture flask originally contained 20 ml. nutrient solution. Every two days each control flask was supplemented with 1 ml. distilled water and each one of the other flasks with 1 ml. distilled water saturated with nonanal. Average values, ± standard errors, taken from four parallel cultures. Temperature, 25° C.

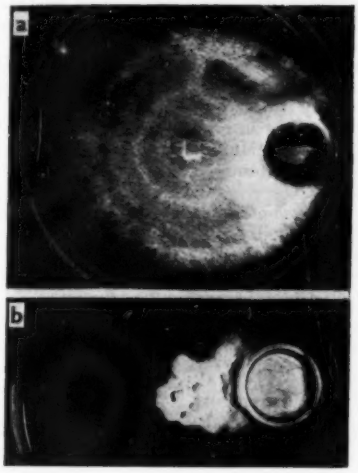

Fig. 1. Two cultures of fungi growing on the synthetic nutrient agar medium. To the right in the Petri dish the cup with a drop of 'Tween 40' containing 5 per cent nonanal (× ½). *a*, *Daedalea unicolor*, 8 days old culture; *b*, *Polyporus applanatus*, 9-day old culture

every two or three days. For these reasons the concentration of nonanal was never constant during the experiment. However, an original concentration of about 10 μmoles per litre, which means about 30 μgm. per flask, was sufficient to produce strong promotion of growth in *Stereum sanguinolentum*.

In the second type of experiment, where the substances to be tested were supplied through the gas phase, the fungi were grown in Petri dishes and the media were solidified with 1·5 per cent agar. The inoculum was placed in the centre of the agar plate. At the periphery, close to the glass wall, a small aluminium cup was introduced, containing the test substance dissolved in 'Tween 40' (polyoxyethylene sorbitan monopalmitate), a solvent which did not in itself affect the growth of the fungi under the conditions of the experiment. Solutions with 5 and 1 per cent (w/w) nonanal were used.

In these experiments the effect of nonanal was obvious in all species and in both tested concentrations, manifesting itself as an increase in the development of aerial mycelium and sometimes also as a faster growth of the substrate hyphæ (Fig. 1*a*). The response of *Polyporus applanatus* was particularly drastic, a high and thick wall of interwoven air hyphæ being formed around the cup containing the nonanal solution (Fig. 1*b*).

With *Stereum sanguinolentum* as test organism, the effect of a few other compounds chemically related to nonanal was studied in liquid culture experiments. Octanal and decanal produced a slight increase in the rate of growth, whereas nonanol and nonanoic acid proved to be completely inactive.

Preliminary experiments have shown that a number of other wood- or soil-inhabiting *Hymenomycetes* also respond positively to nonanal, for example, *Polyporus fomentarius* L. ex Fr., *Mycena metata* Fr., *M. adonis* Fr., *Coprinus narcoticus* Fr. and *Boletus variegatus* Sw. ex Fr.

The question whether Suolahti's wood factor is identical with nonanal, or not, must probably remain unanswered until the wood factor is isolated and analysed. At present it is also impossible to say anything with certainty about the biochemical mechanism behind the growth-promoting activity of nonanal. Earlier investigators have only observed inhibitory effects of this substance[4], except for one case of stimulation of spore germination[5]. Reports on the role of long-chain aldehydes in bacterial bioluminescence[6] and catalase activity[7] may indicate the possibility that nonanal functions in some way as an enzyme activator.

A more detailed report of the methods and results will be published elsewhere.

I am indebted to Prof. A. Fredga for the sample of nonanal.

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[1] Suolahti, O., "Über eine das Wachstum von Fäulnispilzen beschleunigende chemische Fernwirkung von Holz", thesis (1951).
[2] Ellis, G. W., *Biochem. J.*, **30**, 753 (1936). Ralston, A. W., "Fatty Acids and Their Derivatives" (John Wiley and Sons, Inc., New York, 1948). Iselin, E., *Mitt. Gebiete Lebensm. Hygiene*, **40**, 105 (1949).
[3] Fries, N., *Physiologia Plantarum*, **1**, 330 (1948).
[4] Penfold, A. R., and Grant, R., *Proc. Roy. Soc. N.S.W.*, **60**, 167 (1926). Okazaki, K., and Homma, A., *J. Pharm. Soc. Japan*, **74**, 1131 (1954).
[5] French, R. C., and Weintraub, R. L., *Arch. Biochem. and Biophys.*, **72**, 235 (1957).
[6] Cormier, M. J., and Strehler, B. L., *J. Amer. Chem. Soc.*, **75**, 4864 (1953).
[7] Kaplan, J. G., *J. Gen. Physiol.*, **38**, 197 (1954–55).

BACTERIOLOGY

A New Species of Green Sulphur Bacteria

IN 1959 two strains of green bacteria were isolated in pure culture from mud of the Kujalnik estuary (near Odessa) and of Lake Saksky (Crimea).

These strains are identical as to their characters, and in some features they differ from all other green sulphur bacteria studied in pure culture[1]. The micro-organisms isolated are motile, short, rod-shaped cells measuring about 1·0–1·5 × 0·8–0·9μ (Fig. 1). The suspension of cells has absorption maxima at 750 and 457 mμ. The purified green pigment of the bacterium has absorption maxima in ethyl ether at 660, 432 and 412 mμ. These maxima are typical of the chlorophyll of green bacteria[2,3].

Like other green bacteria, the isolated organisms require for their growth anaerobic conditions and light. Good growth is observed on a modified Larsen's medium[2] containing: 0·1 per cent ammonium chloride, 0·1 per cent potassium dihydrogen phosphate, 0·5 per cent magnesium chloride, 2 per cent sodium chloride, 0·1 per cent calcium chloride, 0·3–0·5 per cent sodium bicarbonate, 50 μgm./100 gm. iron (as ferric chloride), 0·1 per cent hydrated sodium sulphide ($Na_2S.9H_2O$) and a complex of trace ele-

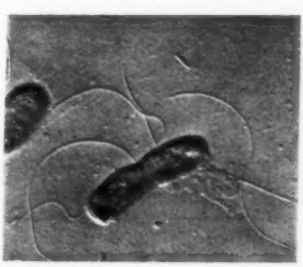

Fig. 1. Electron micrographs of *Chloropseudomonas ethylicum* cells grown on a medium containing ethanol. × 7,000

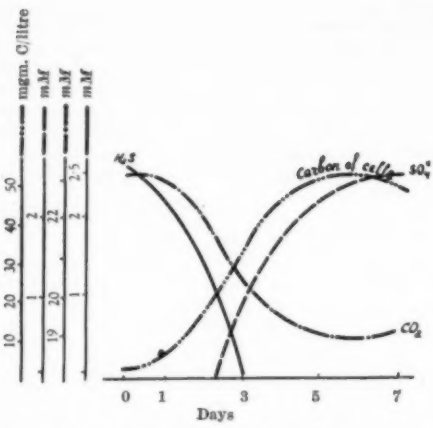

Fig. 2. Photosynthesis of *Chloropseudomonas ethylicum* on a medium containing 0·1 per cent sodium sulphide

ments. The initial *p*H was 7·2; optimal temperature, 28–30° C.

During the growth of bacteria on such a medium, they oxidize the hydrogen sulphide at first to sulphur and then to sulphates (Fig. 2). No growth is observed on a medium containing thiosulphate.

In contrast to all other known free-living sulphur green bacteria, the organisms described are able to utilize for their growth different organic compounds which are added to the medium in quantities of 0·1 per cent together with 0·02 sodium sulphate, necessary for anaerobiosis. The organic compounds maintaining the growth of the bacteria include: acetate, pyruvate, glucose and other sugars. Peptone and some amino-acids are also utilized by the bacteria.

Especially good growth was observed on medium containing 0·1–1 per cent ethanol. The utilization of ethanol by these organisms is followed by the intensive consumption of carbon dioxide and by the production of acetic acid (Fig. 3). Thus the acetic acid appears to be the product of oxidation of ethanol.

During the development of the bacteria on a medium containing ethanol, the quantity of carbon in the cells produced exceeds the carbon content in the carbon dioxide utilized. This indicates that the

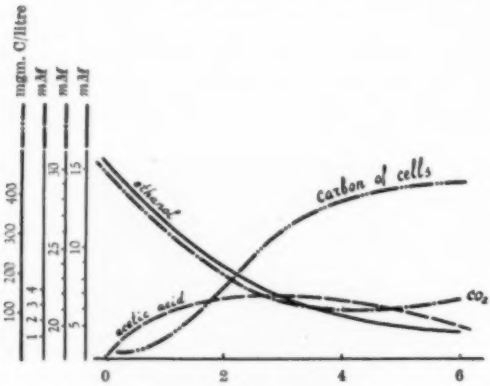

Fig. 3. Photosynthesis of *Chloropseudomonas ethylicum* on a medium containing 0·1 per cent ethanol

bacteria utilize in their constructive processes both the carbon from added sodium bicarbonate and ethanol.

Examination of the organisms isolated leads us to include them in the family Chlorobacteriaceae. In their motility these bacteria are similar to *Chloropseudomonas* Czurda and Maresch[4].

In Bergey's "Manual"[5], *Chloropseudomonas* is included in the genus *Chlorobium*. But no known members of *Chlorobium* show any motility. For this reason it may be more logical to name the green bacteria described *Chloropseudomonas*. As the best development of these bacteria takes place on the medium containing ethanol, we propose as a specific designation *Chloropseudomonas ethylicum*.

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[1] Shaposhnikov, V. V., Kondratieva, E. N., and Ramenskaya, A. A., *Doklady Akademii Nauk S.S.S.R.*, **29**, 6 (1959).
[2] Larsen, H., *Kon. Norske vidensk. Selskabs., Skrifter*, **3** (1953).
[3] Goodwin, T. W., *Biochim. Biophys. Acta*, **18**, 2, 309 (1955).
[4] Czurda, V., and Maresch, E., *Arch. Mikrobiol.*, **8**, 2, 99 (1937).
[5] "Bergey's Manual of Determinative Bacteriology" (1948 and 1957).

Appearance of New Deficient Characters in Streptomycin-resistant Mutants of *Bacillus subtilis*

We have previously reported[1] that a new deficient character, uracil-dependence, appeared through a genetic interaction between two mutant cells of *Bacillus subtilis K*. It has lately been found, however, that the uracil-dependent progeny could be recovered among the colonies which appeared on a streptomycin-containing medium on which cells of a methionine- and histidine-dependent, and streptomycin-sensitive strain (*met,his,str-s*) had been plated[2]. Besides the uracil-dependence, some new characters, for example, histidine-dependence and thiamine- or niacin-dependence, appeared in other streptomycin-resistant mutants of *B. subtilis K*. These facts might have some connexion with the discovery of similar phenomenon in *Salmonella*[3] as well as with the mechanism of drug-resistance.

The first experiment was carried out with the *met, his,str-s* strain. About 5×10^8 cells harvested from a culture in nutrient broth were plated on nutrient agar and a synthetic medium (Gray and Tatum's medium plus methionine and histidine). Each medium contained streptomycin in the amounts shown in Fig. 1. It was found that smaller numbers of resistant colonies appeared on the nutrient agar than on the synthetic medium, and, moreover, the size of the colonies on media with low concentrations of streptomycin were generally smaller than those on media with higher concentrations. To test growth response, all the colonies which appeared on the nutrient agar were printed to the synthetic medium by the replica plating method. At a concentration of 5γ of streptomycin per ml., 8 out of about 10^3 colonies tested could not grow on the synthetic medium. At 10γ/ml., 5 out of 5, at 25γ/ml., 6 out of 9, and at 50γ/ml., 3 out of 3 could not. It was shown by the auxanographic technique that these irregular colonies required uracil for growth in addition to methionine

Table 1. VARIOUS STREPTOMYCIN-RESISTANT MUTANTS OF *B. subtilis K*

Mutant strains	Genotype	Frequencies	Types of Sm.-resistant	New type/Normal	Revertant
A1	*ade,str-s*	10^{-8}	Sm.-dependent, normal	2/0, 0/10	—
A11	*ade,met,str-s*	*c.* 10^{-9}	histidine-dependent	1/0	—
A15	*ade,his,str-s*	10^{-9}	Sm.-dependent, *X*-dependent*, normal	2/4/4	Sm.-resistant
A16	*ade,glu,str-s*	10^{-9}	normal	0/10	—
A2	*ade*$_2$*,str-s*	*c.* 10^{-7}	Sm.-dependent, thiamine-dependent	3/2/0	Sm.-resistant
A17	*ade,ura,str-s*	*c.* 10^{-7}	normal	0/150	—
T1	*try,str-s*	*c.* 10^{-9}	normal	0/7	—
T12	*try,thi,str-s*	*c.* 10^{-9}	normal	0/4	—
M12	*met,his,str-s*	10^{-8}–10^{-7}	uracil-dependent, normal	1,000/0–0/70	Sm.-resistant
L1	*leu,str-s*	*c.* 10^{-7}	normal	0/60	—
Wild	*str-s*	10^{-9}	Sm.-dependent, normal	2/5	Sm.-sensitive

* An unknown factor. Sm., Streptomycin.

and histidine. Because the frequencies of new type appearance per total cells plated were almost equal regardless of the concentration of streptomycin, it is supposed that the *met,his,ura,str-r* mutant cells which had pre-existed in the mother culture of the tester strain were selected by this procedure.

Next, experiments were extended to the nine other biochemical mutants as well as the wild strain of *B. subtilis K* (Table 1). The third column in Table 1 shows the frequencies of recovery of resistant colonies at a concentration of 70–80 γ/ml. of streptomycin. The fourth indicates the type of new characters which appeared, and the fifth the ratio of new types among the resistant colonies obtained. In short, strain *A*11 gave one histidine-dependent, strain *A*1 two streptomycin-dependent colonies, strain *A*2 three streptomycin-dependent and two thiamine- or niacin-dependent. The wild strain gave only two colonies positive for streptomycin-dependence.

Finally, the relationships between the new dependent characters and streptomycin-resistance were examined. The spontaneous reversions of the new genetic characters gave no changes in streptomycin-resistance, and moreover the cross[4] between *T*17 (*try,thi,str-s* and phage-resistant) and the resulting methionine-, histidine-, uracil-dependent and streptomycin-resistant mutant produced the progeny, tryptophan-dependent and streptomycin-resistant and phage-sensitive, but not streptomycin-resistant and uracil-dependent. The results indicated that no close linkage relationship was observed between new deficient characters and streptomycin-resistance, and that each locus behaved independently in reverse mutation and genetic interactions.

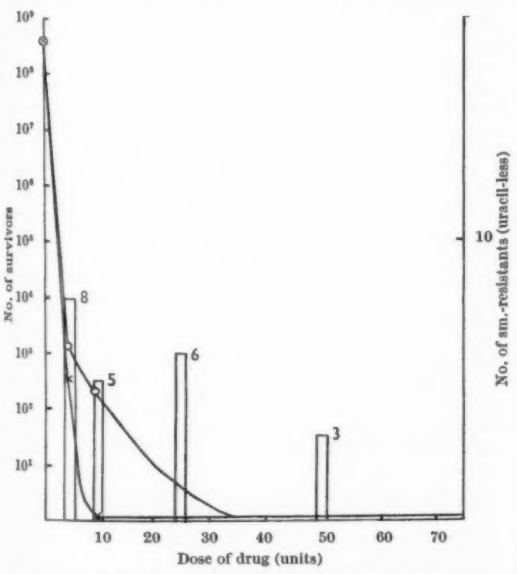

Fig. 1. Broth culture of *M*12 (*met,his,str-s*) was inoculated on to the media containing various concentrations of streptomycin. Synthetic medium, Gray and Tatum's medium; complete medium, nutrient agar. Histograms indicate the total number of uracil-requiring, streptomycin-resistant colonies. ○, on synthetic medium; ×, on complete medium

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[1] Kohiyama, M., and Ikeda, Y., *Nature*, **184**, 208 (1959).
[2] Kohiyama, M., *C.R. Acad. Sci., Paris* (in the press).
[3] Watanabe, T., and Watanabe, M., *J. Gen. Microbiol.*, **21**, 30 (1959).
[4] Kohiyama, M., *Z. Vererbungslehre*, **30**, 347 (1959).

GENETICS

Secondary Selection in Pure Lines of Rice

IT is generally accepted in self-pollinated plants that once a pure line has been isolated no further improvement can be achieved by further selection within that line.

Ghose and Daiya[1] found the increase in yield of secondary selections from pure lines of rice (*Oryza sativa* L.) to be small. Experience in Malaya, however, indicates that a re-selection after a number of years from among populations in a pure line could give significant increases. The selection 'Siam 29' was distributed to farmers round about 1930. This selection eventually practically replaced all the unselected 'Siam' in all areas where this variety was planted. After the Second World War, it was observed that minor differences exist in the 'Siam 29' material collected from various places where this material was distributed. A re-selection was therefore carried out in 1949. Sub-strains isolated from this re-selection were found to be identical in morphological characters to that of 'Siam 29'. Some of these sub-strains have given significant yield increases over 'Siam 29', the control, in variety trials conducted over a three-year period. Results of one of the variety trials is given in Table 1 to show the increases of these sub-strains over 'Siam 29'.

Re-selection in two other varieties, the 'Nachins' and the 'Seraup Kechils', has given similar results. Re-selection in the 'Mayang Sabatils', however, gave very small and insignificant increases.

Since *O. sativa* L. is principally autogamous, and outcrossing is only of the order of 0·41 per cent[2], increases obtained by re-selection in pure lines, such

Table 1. (Ref. 3.) Layout, 5 × 5 Balanced Lattice Square; Plot Size, 1/180 Acre

Variety	Mean yield (lb./acre)			Variety mean	Percentage (cf. Siam 29)
	1955	1956	1957		
Siam *E.R.* 25	4,016	3,373	3,385	3,591	121·9
,, ,, 16	4,060	3,266	3,314	3,547	120·4
,, ,, 56	3,726	3,306	3,234	3,422	116·1
,, ,, 26	3,893	3,147	3,218	3,419	116·0
,, ,, 69	3,679	3,226	3,222	3,376	114·6
,, ,, 59	3,548	3,401	3,127	3,359	114·0
,, ,, 6	3,544	3,214	3,294	3,351	113·8
,, ,, 11	3,695	3,214	3,119	3,343	113·4
,, ,, 54	3,925	3,226	2,845	3,332	113·1
,, ,, 24	3,544	3,044	3,286	3,291	111·7
,, ,, 71	3,599	3,294	2,913	3,269	110·9
,, ,, 48	3,512	3,016	3,064	3,197	108·5
,, ,, 20	3,702	3,056	2,802	3,187	108·1
,, ,, 46	3,726	3,016	2,754	3,165	107·4
,, ,, 10	3,560	3,135	2,800	3,165	107·4
,, ,, 18	3,564	2,857	3,004	3,142	106·6
,, ,, 13	3,143	3,425	2,837	3,135	106·0
,, ,, 72	3,377	3,083	2,929	3,130	106·0
,, ,, 29	3,202	3,000	2,968	3,057	103·7
,, ,, 42	3,353	2,790	2,948	3,030	102·8
,, ,, 38	3,016	3,123	2,893	3,011	102·2
,, ,, 32	3,254	2,671	3,008	2,978	101·1
Siam 29 (Control)	3,417	2,738	2,687	2,947	100·0
Siam *E.R.* 73	3,361	2,726	2,706	2,931	99·5
,, ,, 70	2,806	2,964	2,952	2,907	98·6
Season mean	3,528	3,091	3,012	3,210	
S.E. lb./ac.	± 234	± 186	±131	± 109	

S.E. seasons ± 38 lb./acre; *S.E.* interaction ± 115 lb./acre

as in the above, would indicate that established improved strains are either not totally homozygous or that there is an accumulation of mutations which affected yield.

I acknowledge with thanks the kind permission of the Public Services Commission, Federation of Malaya, to publish this communication.

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[1] Ghose, R. L. M., and Daiya, L. R., International Rice Commission Paper *IRC/BP/52/15* (1952).
[2] Brown, F. B., *Malayan Agric. J.*, **40**, 4 (1957).
[3] Brown, F. B., Sci. Bull. 109, Dept. of Agric. (1959).

Selfing of Self-Incompatible Cocoa

The Upper Amazon cocoa varieties, of great importance to the breeder, are all self-incompatible so that it is difficult to obtain valuable alleles in the homozygous condition[1]. The incompatibility mechanism operates through failure of fusion of male and female gametes carrying the same dominant allele, followed by the loss of the whole ovary even though normal fusion has occurred in other ovules.

Attempts have been made to self a self-incompatible clone ('Nanay 32') by applying a quantity of pollen from a tree compatible with it together with a little of the pollen of the clone itself. The tree used to provide the compatible pollen is homozygous for a marker-gene detectable in the seedlings ('axil spot'). Out of some dozen attempts, one pod was obtained which gave 46 seedlings showing the 'axil spot' character and 4 without it. These four seedlings are thought to be selfed progeny of the clone.

The theory behind the attempt was that if the proportion of ovules in which dominant alleles were combined were sufficiently low the flower may remain on the tree and selfed ovules in which different alleles, or alleles recessive to others present, had come together could develop into seed. 'Nanay 32' has the alleles 2 and 4 on Knight and Rogers's terminology[2], allele 2 being dominant to allele 4. These four seedlings will thus be 2·4 or 4·4, any ovules which were 2·2 having failed.

Posnette[3], who demonstrated that pods could be set on a self-incompatible tree when both its own pollen and pollen from a self-compatible tree were applied to the same flower, suggested a similar method for determining if any of the seeds resulted from self-fertilization. He suggested pollinating a self-incompatible white-beaned tree with both its own pollen and pollen from a compatible tree homozygous for purple-bean, when any white beans obtained would result from self-pollination as the purple-bean characteristic is dominant. Van der Knaap[4] applied pollen from a compatible white-seeded tree to a self-incompatible tree heterozygous for purple and white beans together with its own pollen, and obtained an indication that some selfing was taking place from the lower proportions of white beans in the progenies than when the tree was only crossed. The present work is believed to be the first actually carried out in which it is possible to pick out the selfed seedlings.

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[1] Cope, F., *Nature*, **181**, 279 (1958).
[2] Knight, Ronald, and Rogers, H. H., *Heredity*, **9**, 1, 69 (1955).
[3] Posnette, A. F., *Trop. Agric.*, **17**, 67 (1940).
[4] Van der Knaap, W. P., Rep. Fourteenth Intern. Hort. Cong., **2**, 1287 (1955).

Occurrence of a Brown Mutation in the Syrian Hamster

Cinnamon or 'brown' mutations in species of rodents are well-known modifications of the pigmentary physiology of the wild agouti colour. A comparable mutation is now recorded for the Syrian hamster, *Mesocricetus auratus*, one of the comparatively recent additions to the range of laboratory rodents. The mutant allele is inherited as a recessive to the normal gene and the genetic symbol *b* is proposed for its designation.

In the cinnamon hamster all the eumelanic pigmentation, which is normally black in the wild type, is now changed to brown. The overall effect is a cinnamon-orange of a particularly rich colour. This is due to the fact that the wild agouti Syrian hamster is considerably more auburn than the drab agouti of, say, the mouse or rabbit. The agouti brown mouse or rabbit is much brighter than the black agouti, and this brightening effect is greatly enhanced in the hamster, as a consequence of the initial auric pigmentation. The auburn colour is due to abundant phæomelanin, which is possibly only indirectly affected by the brown mutation. The simplest assumption at present is that the brightening is due to an optical effect; although it is also possible that the modification of black eumelanin to brown could so shift the pigmentary processes that additional phæomelanin is formed out of the chromogenic substrate.

The colour of the cinnamon hamster is a rich cinnamon-orange. The black flashes of the wild type are replaced by brown, as are also the black tips of the coat hairs and the shafts of the vibrissæ. The

dark blue undercolour of the coat is changed to a lighter hue. The pale cream colour of the under-surfaces (jaw, throat and stomach) of the animal are unchanged. The ear auricula are peach-grey instead of black. A most conspicuous alteration has occurred in the eye colour, where, by reflected light, the pupil glows a rich sanguine red. This feature is more pronounced than that found in cinnamon mutants of the mouse or rabbit. It would suggest a relatively severe reduction in the quantity of eumelanin present in the various eye tissues.

The eye colour of the cinnamon is a brighter red than that found in the genetically distinct ruby-eye dilute (*ruru*) hamster[1]. In this mutant type the eye colour, viewed by a reflected light, is a dull ruby red. The two mutants cannot be confused, for the ruby-eye animal has a diluted bluish-fawn coat. It is of interest that the gene combination *bbruru* exhibits the action of both mutant genes. The coat colour is a soft cinnamon-beige while the eye colour is a translucent red, lighter and distinctive from that of either the cinnamon or ruby-eye. It has also been observed that the *b* allele is hypostatic to the cream (*ee*) mutation[1], except for eye colour. The genotype *BBee* has cream-yellow fur colour, while the genotype *bbee* also has cream fur plus the red-eye colour associated with *b*.

The mutant allele was discovered in the United States during the early part of 1958 by a hamster fancier, and animals carrying the gene were imported into Britain in the early months of 1959. An imported male bred to normal females produced an F_1 of 100, all of which were wild type. The F_2 generation consisted of 148 ♂♂ *B*, 160 ♀♀ *B*, 44 ♂♂ *b* and 63 ♀♀ *b*. The observed segregation of cinnamon offspring is a good fit to a 3 : 1 ratio ($\chi_1^2 = 0{\cdot}14$; $P \simeq 0{\cdot}70$), and the sex ratio is a good approximation of equality ($\chi_1^2 = 2{\cdot}17$; $P > 0{\cdot}10$). A test for possible partial sex linkage in the segregation above was completely negative ($\chi_1^2 = 1{\cdot}63$; $P \simeq 0{\cdot}20$).

The evidence presented in the above paragraphs indicates that the cinnamon-orange phenotype of the Syrian hamster is inherited as a monogenic, autosomal, recessive character. It is suggested that the mutant allele is a probable homologue of the brown mutation known in several other species of rodents.

I wish to acknowledge the kind co-operation of Mrs. Margaret Beher in obtaining specimens of cinnamon hamsters.

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[1] Robinson, R., *Nature*, **176**, 353 (1955); *J. Genet.*, **56**, 85 (1958).

PSYCHOLOGY

Experimental Evidence for Extra-Sensory Perception

SINCE making my reply (*Nature*, **185**, 949) to Mr. C. E. M. Hansel's communication in *Nature* of November 7, 1959, I have examined the question in greater detail. The periodic segmental effect noted by Mr. Hansel is, I find, entirely restricted to the experiments done at the 'rapid rate' of calling ; in the much larger group of 6,039 (+1) trials aimed at normal speed, the effect does not appear. As the reader may easily verify by means of Table XXXII of Appendix D (p. 139) of the original Shackleton report (*Soc. Psych. Research Proc.*, Part 167), there is no significant decline in the segments of the run and the corresponding graph shows an absence of any marked pattern. This provides a strong argument against the hypothesis that the guesser arranged his 'hits' so as to fall on certain pre-assigned positions in the scoring sheet.

Mr. Hansel suggested that an inspection of the positions of the (+2) hits on the scoring sheets concerned might throw light on the question. I therefore tabulated the hits in positions 1–23 for every column of the 'rapid rate' experiments. At first sight I was struck by the number of hits in a column which were spaced at a common interval. For example, column 7(*b*) on March 28 contained 11 hits in the positions 3, 4, 6, 7, 10, 11, 14, 18, 20, 21, 22. Of these, five are spaced at four trials apart, that is (6, 10, 14, 18, 22). But I discovered that such regularities can be obtained quite as frequently from a table of random numbers. I opened Tippet's table at page II, in which the random digits are arranged in columns of two-figure numbers.

Starting at the top of the first column and working down the succeeding columns in order, I constructed random positions in the column for a total of 10 hits as follows. Passing over the two-figure numbers 92–99 for obvious reasons, but retaining 00, each number was divided by 23 and the remainders noted. This was continued until 10 remainders were obtained which represented a random distribution of 10 (+2) hits in the first 23 places of the column, the remainder 0 standing for place No. 23. This process was continued until the first 47 sets of 10 hits were obtained. No gaps were left except those corresponding to the numbers 92–99, and of course the same remainder was not used more than once in a set of 10.

In the first 47 sets of 10 (+2) hits formed in this way, there were 17 with $\geqslant 5$ hits spaced at equal intervals.

For example, the first of these begins at II (1) 14, which means at the fourteenth entry down the first column of page II of Tippett's random numbers, and the seventeenth begins at II (14) 12.

There were also 16 sets of 10 each of which contained 4 hits spaced at equal intervals The first. of these begins at II (2) 21 and the last at II (13) 48.

In the actual experiment there are 11 columns with scores ranging from 9 to 12 and so comparable with the control series, and these comprise 4 columns each with 5 hits equally spaced. These occur on March 21, 1941 Col. (6*b*), March 28, 1941 Col. (7*b*), March 28, 1941 Col. (8*b*) and April 18, 1941 Col. (7*a*).

A simple contingency table :

17 4	30 7	47 11
21	37	58

gives $\chi^2 = 0{\cdot}02$ with $0{\cdot}8 > P > 0{\cdot}7$, which is not abnormal, and this shows that regularly spaced hits occur quite as frequently in a random distribution as they do in the actual experiment.

The 11 columns of the actual experiment comprise 5 columns each with 4 hits equally spaced. These occur on March 21, 1941, Col. (6*a*), April 18, 1941, Col. (5*a*), May 22, 1942, Cols. (2*b*) and (3*b*), and June 5, 1942, Col. (1*b*).

The appropriate contingency table (without Yates's correction) gives $\chi^2 = 0{\cdot}47$, which again has no significance.

Mr. Hansel's view that segmental salience effects are due to faulty experimental design seems improbable, owing to the many experimenters who have observed such effects.

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As I said in my last reply, if a trick was used it would "possibly but not necessarily reveal itself by causing a periodicity to arise in the scores". Thus the fact that a periodicity is not present in the results obtained at the 'normal rate' does not indicate that a trick was not employed in those experiments. The pooled results for the 'rapid-rate' experiments comprise the scores from six sittings whereas the results for the 'normal-rate' experiments include the scores from some thirty sittings. There was thus a greater opportunity for a thorough randomization of the code in the latter case, and as I said in my original letter the periodicity effect would only arise if the five possible arrangements (that is, using lines 5, 10, 15, 20 or lines 6, 11, 16, 21, etc.) were not used equal numbers of times. In addition, other sequences—such as every fourth line number—could have been used part of the time to mask any periodicity effect. In the case of both the 'rapid rate' and the 'normal rate' experiments, the pooled results include scores obtained when two different techniques were used to determine the targets, and when the percipient worked with two different agents. Also the scores at the different positions in the two columns of twenty-five spaces on the score sheet were combined in the tables. It is thus surprising that the periodicity is present to such a marked extent even in the results of the rapid-rate experiments.

Dr. Soal's analysis of the frequencies with which unbroken runs of hits occur at equal spacings on the score sheets throws no further light on the experiments. Both Dr. Soal's empirical estimates and the values he obtained from the score sheets agree closely with the theoretical values which may be calculated. This result, however, merely discredits the hypothesis, formulated by Dr. Soal, that the score sheets have an unusually large number of cases where four or five hits are spaced, at a common interval.

If a trick was employed, we should not necessarily expect runs of hits at even spacings to appear at above the chance-level. Thus even if the percipient were to attempt to obtain five hits at five equally spaced positions, his ability to do so would depend on suitable random numbers appearing. If, for example, he wrote down different symbols at these five positions, the agent could only assist him to obtain five hits in the event of five different random numbers appearing at these five positions ($p = 0{\cdot}0384$). But also, Dr. Soal's analysis included all such runs whether spaced on every fifth line or at other intervals. If a trick was used employing every fifth line number, this would tend to produce a deficiency of hits at smaller spacings when the expected frequencies are calculated on the basis of hits randomly disposed over the column.

Dr. Soal selected the highest eleven scoring columns for his analysis; but it should be noted that the average score was about seven hits per column of twenty-five guesses (twenty-three of which could be scored). The percipient would have had to obtain about three hits by means of a trick in each column of the score sheet, in order to achieve scores similar to those obtained in the experiment.

Dr. Soal does not say how many experiments have been produced in which the results show a segmental salience effect, and I suspect that 'many' is certainly less than ten. Even if a high proportion of the experiments on extra-sensory perception have shown a segmental salience effect, I would not regard the suggestion that such effects are due to faulty experimental design as improbable.

Dr. Soal has himself revealed many weaknesses in the experimental work of other investigators in this sphere, and as I have pointed out elsewhere[1], I have been unable to find satisfactory evidence for extra-sensory perception in spite of many attempts to obtain it. If precognitive telepathy does not take place owing to processes not existing in Nature which permit its occurrence—as I consider to be the case—something must be responsible for the highly significant results obtained in some of the experiments and not in others. Whatever it is can be included in the general term 'experimental error'. While it is of interest to know what causes experimental error to arise, we must await a foolproof experimental design and a result which can be confirmed by other independent investigators before having to consider seriously the hypothesis of extra-sensory perception as an alternative explanation. The presence of a segmental salience effect must be taken in conjunction with the fact that there is a weakness in the experimental design which permits the result to arise by means of processes which are well understood, and that exploitation of this weakness without sufficient care would inevitably produce the salience effect.

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[1] Hansel, C. E. M., *New Scientist*, **5**, No. 119 (1959).

Preliminary Psychomotor Stress Studies with Subnormal Psychopathic Subjects

In a series of research studies concerned with stress reactivity in adult male patients of subnormal intelligence quotient (*I.Q.*) and of known delinquent or psychopathic history, it has been established that stability, and possibly prognosis, are related to behavioural and physiological measures of stress reactivity[1,2]. Stress reactivity has been regarded as a continuous single variable, and it seems that instability corresponds with very high or very low reactivity, and stability with moderate reactivity, findings which are similar to those of Lykken[3], for primary and neurotic sociopaths, and the views of Eysenck[4,5] and Franks[6,7], concerning introversion–extraversion and conditionability. In general, physiological measures, such as the conditioning-rate of the galvanic skin response, correlate more highly with various social criteria than do behavioural measures. This is for three reasons: (*a*) the physiological techniques reduce extraneous stimulus and response factors to a minimum; (*b*) the techniques are applicable to subjects of quite low *I.Q.*, for example, down to 60; (*c*) the responses usually indicate a required range of scores from unreactivity to high reactivity.

There is clearly much in common with this stress reactivity variable, Eysenck's continuum of varying excitatory/inhibitory balance and Davis's[3] continuum of inertia-overactivity, which was originally determined from flying personnel research. Techniques aimed to assess Davis's psychomotor variate carry fewer disadvantages than most behavioural measures of stress reactivity in that the intellectual requirements need not necessarily be high, and the response can be assessed along a continuum from unreactivity to high reactivity. Venables[9,10] designed such a technique to demonstrate psychomotor differences between dysthymics and hysterics, and also found a close relationship between the psychomotor response and autonomic reactions. Using the same technique, Anthony[11] found highly significant differences between the psychomotor responses of delinquents and non-delinquents among Air Force personnel, with indications that the variate carries a high predictive validity.

In view of this similarity in conclusion from the different research sources, and also in view of the possibility that the Davis–Venables–Anthony technique might be of practical use in a battery of stress reactivity tests designed to predict behaviour for subnormal psychopaths, a series of experiments was instigated. These were designed to determine: (*a*) the relationship this variate has to galvanic skin response conditioning score (stress reactivity); (*b*) the main constituent of the psychomotor stressor, that is, whether it is speed stress or load stress[12] or both; (*c*) the modifications necessary to make the technique more practicable for low *I.Q.* subjects.

The original test required the subject to move a lever to the left or to the right, and back to the original position, in response to signal lights which flashed on a display panel at regular intervals. The lever operated a pen writing on moving paper, which recorded the amplitude of the subject's response (R), and the time taken (W), giving a third index R/W or speed. The test was in three consecutive parts, namely, series A, simple stimulus conditions at a moderate rate of presentation; series B, complex stimulus conditions at a higher rate of presentation, and C, identical to series A. Both Venables and Anthony found that the indices most highly associated with psychiatric or social criteria were: (*a*) the general score-level for speed, R/W, under all stimulus conditions; (*b*) the difference in speed under conditions B and C; (*c*) the direction of change, that is, increase or decrease in speed.

For practical purposes, and in order to overcome the time-consuming measurement of 150 individual responses for each patient, modified apparatus was designed and constructed with the aid of money made available by the Mental Health Research Fund. As in the previous experiments by Venables and Anthony, the subject is required to move a lever from a centre position to the right or to the left in response to visual signals on a display panel. With the new technique the lever is arranged to activate a 10 counts/sec. electronic pulse clock on being moved off centre. An electromagnetic counter driven by the clock indicates the integrated time variate (W). To the lever is also attached a series of gear wheels and ratchets allowing its total integrated movement (the amplitude of the response, R), to be read directly from a revolving scale. Stimulus presentation has been automatized by using a pulsed uniselector so that the whole test, involving 150 stimulus-response pairings and calibration, occupies 7–10 min.

Five experimental trials have been carried out with different groups of 20 patients of *I.Q.* range 60–90, and one trial with normal male adults. Trial 1 followed the Venables–Anthony stimulus presentation procedure in respect of both speed stress (time interval between stimuli) and load stress (the complexity of the stimuli), and was found to be beyond the capabilities of too many patients. Trial 2 used the load stress but left the presentation-rate constant at a moderate level for series A, B and C. No significant correlation coefficients were found between any psychomotor variate and conditioning score. Trial 3 investigated the practice effect by presenting series A conditions three times in succession and comparing the resultant scores with those for trial 2. No significant differences were found, and it was concluded that the load stress, on its own, is unimportant in producing significant behaviour for these patients, with this test. In view of this, the subsequent experiments investigated the rate of presentation factor in relation to galvanic skin response conditioning with load conditions uniform for series A, B and C. No significant correlation coefficients were found for trial 4, when the rate of presentation was increased from 30 signals a minute in Series A and C to 50 signals a minute in series B. In trial 5, the rate of presentation was further increased to 60 signals a minute in series B, and this was found to produce a psychomotor stress reaction which correlated slightly with the conditioning score for the galvanic skin response. The measure used was the variate R/W, or speed, for series B, and the difference in R/W between series B and C. Assessed against galvanic skin response conditioning score, $\chi^2 = 3{\cdot}6$ and $3{\cdot}4$ respectively, $P = 0{\cdot}05$. The normal subjects were tried at a presentation-rate of 50 signals a minute, but R/W scores did not differ significantly from those of the patients under the same conditions.

No firm conclusions are possible at this stage; but the indications are that Anthony's finding concerning psychomotor stress in relation to relatively mild delinquent instability, can be associated with the general concepts of stress reactivity applied in the laboratory assessment of more severe psychopathic instability. The automatized technique has considerable practical appeal, but it seems necessary to concentrate more upon the rate of stimulus presentation stressor than the stimulus load stressor, and judicious experimentation with the former may provide valuable information.

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[1] Tong, J. E., *J. Ment. Sci.*, **105**, 935 (1959).
[2] Tong, J. E., and Murphy, I. C., *J. Clin. Psychol.* (in the press).
[3] Lykken, D. T., *J. Abnorm. Soc. Psychol.*, **55**, 6 (1957).
[4] Eysenck, H. J., *J. Ment. Sci.*, **101**, 28 (1955).
[5] Eysenck, H. J., *J. Ment. Sci.*, **105**, 61 (1959).
[6] Franks, C. M., *J. Abnorm. Soc. Psychol.*, **52**, 143 (1956).
[7] Franks, C. M., *Brit. J. Delinq.*, **6**, 192 (1956).
[8] Davis, D. R., "Pilot Error: Some Laboratory Experiments" (H.M. Stationery Office, 1948).
[9] Venables, P. H., *Brit. J. Psychol.*, **46**, 2 101 (1955).
[10] Venables, P. H., *J. Gen. Psychol.*, **55**, 199 (1956).
[11] Anthony, H. S., *Nature*, **183**, 343 (1959).
[12] Conrad, R., *Brit. J. Indust. Med.*, **8**, 1 (1951).

ANTHROPOLOGY

Artificial Thickening of Bone and the Piltdown Skull

One of the few things about the Piltdown bones which has not been settled is the unexplained thickness of the cranial bones. The maximum thickness of the parietal bones, for example, is 12 mm. While this can occasionally be matched in a contemporary skull, such a thickness is seldom encountered in a normal skull. Severe chronic anæmia has been suggested as a possible explanation. It occurred to me that fraud might be at least as good an explanation. Since the faker (or hoaxer) faked everything he could, why not also the thickness of the skull bones? But how does one cause skull bones to thicken? A hydroxide would seem a likely agent. Some potassium hydroxide being readily available 4½ oz. were dissolved in 36 oz. of tap-water, and in this solution was immersed the right posterior three-fourths of a human parietal bone of an adult male. The bone was a dissecting-room specimen of an individual who died about thirty years ago, and had been degreased in the customary manner with peroxide. It was immersed at 3.50 p.m. on April 15. After remaining, undisturbed, for 6 days in this solution the bone had considerably thickened and become as soft as butter. The bone was gently removed with a ladle at 4.15 p.m. on April 21, and put on a plate. An attempt to wash it under a gentle spray resulted in the removal of innumerable small particles of bone from the inner and outer tables, which rapidly formed a sediment about ¾ in. thick and a little more than an inch square. The bone was placed in the open air to dry, which it did within 5–6 hr., accompanied by much flaking away of the inner and outer tables. No attempt was made to harden or otherwise treat the bone. The bone is now somewhat less thick than when it was first removed from the solution, but in its dried somewhat delaminated state it is thicker than the untreated bone, at the corresponding margins, by some 2–2·5 mm. Where the untreated portion of the same skull bone is at the margin (which was artificially produced by a blow with a hammer which broke the skull into four pieces), 6·2 mm. in thickness, the treated bone is at the corresponding margin 8·7 mm. in thickness. I am confident that with a little more patience one could do a great deal better than that.

As in the Piltdown bone so, too, in this artificially thickened bone the diploe has undergone most expansion, while the inner and outer tables have remained relatively thin.

It is not suggested here that the hoaxer used potassium hydroxide to thicken the Piltdown skull bones. It is suggested that quite possibly he used a similar means.

The results of this experiment raise the question as to whether the thickness of palæolithic human skull bones may not, at least in part, be due to the action of various substances in the soils in which they have lain.

My thanks are due to the Department of Geology, Princeton University, for supplying me with the potassium hydroxide used in this experiment.

Ashley Montagu

Princeton, New Jersey.

The results of the experiment carried out and described by Dr. Ashley Montagu are certainly most interesting; but they cannot be considered as providing a possible explanation of the unusual thickness of the Piltdown cranial bones, for two reasons: (1) Chemical analyses have confirmed that the Piltdown cranial bones are slightly mineralized (for example, they contain 0·1 per cent adsorbed fluorine); indeed the conclusion that they are sub-fossil has recently been confirmed by radiocarbon dating[1]. Sub-fossil bones which have lost a considerable proportion of their collagen matrix obviously will not be expanded appreciably by any chemical treatment—or at least not to an extent anywhere nearly comparable with that occurring in the case of a dissecting-room specimen with full collagen content. (2) The striking uniformity and small size of the diploic spaces in the Piltdown cranial bones are incompatible with any artificial expansion.

In the British Museum collections here there are other crania with walls not only as thick as those of the Piltdown cranium, but also showing the same combination of naturally thickened diploe and extremely thin inner and outer tables. The two most striking examples are the cranium of an Ona Indian from Tierra del Fuego, which has already been figured in comparison with Piltdown[2], and a Bronze Age skull from Sutton Courtenay in Berkshire (Oxf. *E*.113. 227).

Kenneth P. Oakley

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British Museum (Natural History),
London, S.W.7.

[1] *Nature*, **184**, 224 (1959).
[2] *Bull. Brit. Mus.* (*Nat. Hist.*), *Geol.*, **2**, No. 6, 259 (1955).

MISCELLANY

The Serengeti National Park

The interesting article on this subject by Dr. A. S. Thomas in *Nature* of May 21, p. 605, seems to call for the following comments:

(1) The new northern extension of the Park ('fly-bush' country without human inhabitants) was not added for the sake of antelopes, but because it was reported to be rich in elephant and rhinoceros.

(2) The southern boundary of the Park was, in the west, pushed outwards practically to the edge of present cultivation; the overspill of the ungulate migration to the south-east falls largely in the Conservation Unit under Government administration or in areas to some extent controlled with regard to 'game'.

(3) It is known, at least in respect of some types of ground, what may be expected to happen when pastoral activity is eliminated; large parts of the Park were already free from this. Moreover, in what is now the Conservation Unit (Ngorongoro) wild animals and domestic herds will continue to co-exist.

(4) The withdrawal of the Park boundaries from an area where human utilization could not be eliminated, that is, the Conservation Unit, was recommended mainly because experience has shown that dual control by Trustees and Government is unsatisfactory; and only where there is no human occupation can Government allow park trustees a clear field. In the Conservation Unit the Government has an opportunity of demonstrating what can be done in the way of reconciling conservational and pastoral interests—an experiment of great interest, on lines such as Dr. Thomas suggests.

Landsborough Thomson

Zoological Society of London.

FORTHCOMING EVENTS

Wednesday, July 13

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Special General Meeting.

Friday, July 15—Friday, July 22

SIXTH COMMONWEALTH MYCOLOGICAL CONFERENCE (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GEORGINA McROBERT RESEARCH FELLOW (with histological training and preferably some experience in immunological methods), to collaborate in the immunopathological research programme being carried out in the Departments of Pathology, Bacteriology and Biological Chemistry—The Secretary, The University, Aberdeen (July 14).

HEAD (graduate, with good industrial and teaching experience) OF THE ENGINEERING DEPARTMENT (CIVIL, ELECTRICAL AND MECHANICAL ENGINEERING)—The Principal, Dudley and Staffordshire Technical College, Dudley (July 15).

RESEARCH FELLOW IN PURE SCIENCE—The Secretary, Durham Colleges in the University of Durham, 38 North Bailey, Durham (July 15).

LECTURER IN CHEMISTRY, and a LECTURER IN CHEMICAL ENGINEERING at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (July 15).

ASSISTANT, Grade B (graduate in mathematics, science or engineering or with equivalent qualifications, and capable of teaching the subject up to H.N.C. and G.C.E. Ordinary standard) IN MATHEMATICS—The Principal, Derby and District College of Technology, Kedleston Road, Derby (July 16).

ASSISTANT LECTURER (with a special interest in the general field of invertebrate palæontology) IN PALÆONTOLOGY—The Secretary, University College, Gower Street, London, W.C.1 (July 16).

CHEMIST (Assistant Experimental Officer grade) IN THE PEDOLOGY DEPARTMENT—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (July 16).

LECTURER IN PHYSICAL METALLURGY at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (July 16).

RESEARCH STUDENTS (with a good degree in physics or mathematics) for experimental and/or theoretical work on a variety of problems including: properties of ionized gases, plasma physics, geophysical hydrodynamics, rock magnetism, study of the Earth's interior, and geomagnetism—The Administrative Assistant, Department of Physics, King's College (University of Durham), Newcastle upon Tyne 1 (July 16).

ASSISTANT LECTURER (with a special interest in field ecology, pollen analysis or experimental taxonomy) IN BOTANY—The Registrar, The University, Sheffield (July 18).

RESEARCH FELLOW (graduate or person experienced in biochemistry) IN THE DEPARTMENT OF PHARMACOLOGY, to work as part of a research team investigating various aspects of rheumatism and other diseases—The Secretary, The Welsh National School of Medicine, 34 Newport Road, Cardiff (July 18).

UNIVERSITY RESEARCH STUDENTS IN THE DEPARTMENTS OF BOTANY, GEOGRAPHY AND PHYSICS—The Registrar, The University, Hull (July 18).

RESEARCH ASSISTANT (with an honours degree in geology, a good background in chemistry, and an interest or postgraduate experience in sedimentary studies) IN THE DEPARTMENT OF GEOLOGY, to work on recent sediments—The Secretary, University College, Gower Street, London, W.C.1 (July 20).

RESEARCH ASSOCIATE (graduate, with special qualifications in physical chemistry, physics or mineralogy and petrology) IN THE DEPARTMENT OF GEOLOGY, for work upon hydrated alumino-silicate glasses and metals and for the development of apparatus for such work—Prof. F. W. Shotton, University of Birmingham, Edgbaston, Birmingham 15 (July 21).

LECTURER IN THE DEPARTMENT OF ORGANIC CHEMISTRY, University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia and London, July 22).

JEYES' RESEARCH FELLOW (suitably qualified graduate) IN THE BIOLOGY DEPARTMENT, for research on biological or physico/chemical aspects of chemical soil sterilization—The Registrar, University College of North Staffordshire, Keele, Staffs (July 23).

ASSISTANT DIRECTOR OF GRADUATE STUDIES IN THE DEPARTMENT OF PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (July 25).

ANALYTICAL CHEMIST (with a degree in chemistry or A.R.I.C.) AT RUAKURA ANIMAL RESEARCH STATION, New Zealand, to assist the officer in charge of the Biochemical Servicing Section of the Research Station, and to undertake non-routine analysis and to develop new methods—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. B.11/2/31 (July 30).

ASSISTANT LECTURER IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Manchester 13 (July 30).

ASSISTANT LECTURER or LECTURER IN INORGANIC CHEMISTRY—The Secretary, The Royal College of Science and Technology, Glasgow (July 30).

CHEMIST, Grade 3 (preferably M.Sc. in analytical and organic chemistry or biochemistry) IN THE NATIONAL BIOLOGICAL STANDARDS LABORATORY, Canberra, for the development of methods for the analysis of drugs, etc.; checking of methods submitted by manufacturers; and the supervision of testing of drugs sold in Australia—The Director-General of Health, Department of Health, Canberra, Australia (July 30).

HEAD (with scientific training to graduate level, not necessarily in textile technology, but possibly in engineering or physics) OF THE DEPARTMENT OF TEXTILE INDUSTRIES—The Principal, College of Technology, Belfast (July 30).

LECTURERS IN MATHEMATICS, PHYSICS, AND BIOLOGY at the Royal University of Malta—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (July 30).

PHYSICIST/MATHEMATICIAN (graduate with a higher degree in physics or mathematics) at the New Zealand Oceanographic Institute, Department of Scientific and Industrial Research, Wellington, to carry out research in various branches of physical oceanography, for example, the dynamics of ocean systems; mixing processes; behaviour of water masses in boundary areas; or other aspects of the transfer of energy between atmosphere and ocean—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. B.11/21/29 (July 30).

LIBRARIAN (male graduate with a library qualification, and preferably a scientific background)—The Secretary, Royal Veterinary College (University of London), Royal College Street, London, N.W.1 (July 31).

SENIOR LECTURER IN PHYSICAL CHEMISTRY at the University of Natal, Pietermaritzburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa and London, July 31).

SENIOR LECTURER IN PHYSICS at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (August 15).

CHAIR OF EDUCATION in the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa and London, August 31).

LECTURER IN ARCHÆOLOGY—The Secretary of University Court, The University, Glasgow (August 31).

LECTURER/SENIOR LECTURER IN ZOOLOGY; and CHAIR IN THEORETICAL PHYSICS at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia and London, August 31).

LECTURER (with an honours degree in psychology together with acceptable qualifications and practical experience in clinical psychology) IN PSYCHOLOGY at the University of Canterbury, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand and London, August 31).

DEPARTMENTAL DEMONSTRATOR IN BIOCHEMISTRY—The Administrator, Department of Biochemistry, The University, South Parks Road, Oxford (September 15).

ASSISTANT, Grade B (preferably with teaching experience) IN THE DEPARTMENT OF CHEMISTRY, COLOUR CHEMISTRY AND DYEING, to teach general and inorganic chemistry to H.N.C. standard—The Principal, Huddersfield College of Technology, Huddersfield.

ASSISTANT LECTURER (preferably with a Ph.D. in microbiology and research experience in this field) IN THE DEPARTMENT OF INDUSTRIAL MICROBIOLOGY—Prof. E. Küster, Department of Industrial Microbiology, University College, Ardmore House, Stillorgan Road, Dublin.

BIOCHEMICAL ASSISTANT to assist with diabetic research—The Director, Medical Unit, King's College Hospital Medical School, Denmark Hill, London, S.E.5.

BIOCHEMIST, Basic grade (graduate in chemistry or Associate or Graduate Member of the Royal Institute of Chemistry), IN THE DEPARTMENT OF PATHOLOGY—The Group Secretary, Queen Elizabeth Hospital for Children, Hackney Road, London, E.2.

HOSPITAL PHYSICIST (with one or two years previous experience) IN THE DEPARTMENT OF PATHOLOGY, for radioisotope work covering a wide field—The Group Secretary, Queen Elizabeth Hospital for Children, Hackney Road, London, E.2.

LABORATORY TECHNICIAN (male or female, A.I.M.L.T., and preferably with experience in blood transfusion work) IN THE UGANDA GOVERNMENT MEDICAL DEPARTMENT—The Crown Agents, 4 Millbank, London, S.W.1, quoting Ref. M.3C/52442/NF.

LECTURER or ASSISTANT LECTURER (Grade B) IN THE DEPARTMENT OF APPLIED PHYSICS—The Principal, Welsh College of Advanced Technology, Cathays Park, Cardiff.

LECTURER or ASSISTANT LECTURER IN PHYSICS at the University College of the West Indies—The Secretary, Inter-university Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

MATHEMATICAL PHYSICISTS (capable of leading teams in theoretical research, and proved ability to do effective work in novel fields)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. 2696/34.

POSTDOCTORAL FELLOW IN ORGANIC CHEMISTRY, to work in collaboration with Dr. E. J. Forbes on the photochemistry of tropolones and related topics—The Deputy Registrar, The University, Edgbaston, Birmingham 15.

POSTDOCTORATE FELLOW IN THE CHEMISTRY DEPARTMENT, for work on infra-red emission from gaseous chemical reactions—Prof. J. C. Polanyi, Department of Chemistry, University of Toronto, Toronto, Ontario, Canada.

PROFESSOR or ASSOCIATE PROFESSOR OF MATHEMATICAL PHYSICS; and ASSISTANT PROFESSORS (2) IN APPLIED MATHEMATICS or MATHEMATICAL PHYSICS at the Royal Military College of Canada—Dept. 2099, National Employment Service of Canada, 61 Green Street, London, W.1.

RESEARCH ASSISTANT (recently qualified organic chemist or biochemist) to undertake work on a chemical problem connected with cancer research—Professor Green, Department of Experimental Pathology and Cancer Research, The University, Leeds 2.

RESEARCH ASSISTANT (suitably qualified graduate) IN BOTANY AND ZOOLOGY, to work on problems in cyto-chemistry, entomology, animal ecology or freshwater biology—Dr. J. K. Spearing, Head of the Department of Botany and Zoology, Sir John Cass College, Jewry Street, London, E.C.3.

SCIENTIFIC OFFICER, Basic grade (with a science degree, and preferably a specialized knowledge of blood transfusion techniques) IN THE LABORATORIES OF THE SOUTH LONDON TRANSFUSION CENTRE, for duties consisting partly of practical laboratory work and research and also to take part in the administration of the department—The Director, South London Transfusion Centre, Stanley Road, Sutton, Surrey.

SENIOR LECTURER IN APPLIED MATHEMATICS, and a LECTURER IN MATHEMATICS at Fourah Bay College, The University College of Sierra Leone—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

TECHNICAL OFFICER (age 22 to 25), with a degree in mathematics, or an honours degree in geography with a mathematical background) IN THE SURVEY DEPARTMENT, Government of Kenya, for survey computations and checking of survey plans—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.103/7/09/NF.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Planning, Vol. 26, No. 441 (25 April, 1960): Consumer Protection and Enlightenment. Pp. 105–136. (London: Political and Economic Planning, 1960.) 3*s.* 6*d.* [254

Ministry of Housing and Local Government. Third Progress Report of the Standing Technical Committee on Synthetic Detergents. Pp. 18. (London: H.M. Stationery Office, 1960.) 1*s.* 6*d.* net. [254

The Imperial Forestry Institute, University of Oxford. Thirty-fifth Annual Report, 1958–59. Pp. 28. (Oxford: Imperial Forestry Institute, The University, 1959.) [254

National Coal Board. The Case for Coal. Pp. 24. (London: The National Coal Board, 1960.) [254

The Institute of Fuel. Report of the Council and Statement of Accounts for the year 1959. Pp. 16. (London: Institute of Fuel, 1960.) [254

Petroleum Information Bureau. U.K. Petroleum Industry Statistics Relating to Consumption and Refinery Production 1958 and 1959. Pp. 10. (London: Petroleum Information Bureau, 1960.) [254

Department of Scientific and Industrial Research. Problems of Progress in Industry No. 6: Training Made Easier: a Review of Four Recent Studies. Pp. 30. 2*s.* Problems of Progress in Industry No. 7: The Older Worker and His Job. By Hilary M. Clay. Pp. 20. 1*s.* 3*d.* (London: H.M. Stationery Office, 1960.) [254

National Institute of Oceanography. Collected Reprints, Vol. 7. Reprints Nos. 248–281. (Wormley, Godalming: National Institute of Oceanography, 1959.) [254

Government of Northern Ireland: Ministry of Agriculture. Leaflet No. 24: Liver Fluke Disease. Pp. 4. Leaflet No. 40: Grassland Husbandry. Pp. 27. Leaflet No. 143: The Cattle Crush. Pp. 4. (Belfast: Ministry of Agriculture, 1960.) [254

Department of Scientific and Industrial Research. Forest Products Research. Bulletin No. 25: Identification of Hardwoods: a Lens Key. Second edition. Pp. vi+126+8 plates. (London: H.M. Stationery Office, 1960.) 7*s.* 6*d.* net. [254

Other Countries

Organization for European Economic Co-operation. Co-operation in the Field of Scientific and Technical Research. Report by Mr. D. Wilgress. Pp. 27. (Paris: Organization for European Economic Co-operation, 1960.) [224

Trinidad and Tobago. Zoologist's Annual Report for 1958. Pp. 11. (Trinidad: Government Printing Office, 1959.) [224

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Flore du Congo Belge et du Ruanda-Urundi. Vol. 9: Spermatophytes. Préparée par le Comité exécutif de la Flore du Congo Belge et le Jardin Botanique de l'État. Pp. vi+597 (56 planches). (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1960.) [224

National Academy of Sciences—National Research Council. Subcommittee on Radiochemistry. NAS–NS–3002: The Radiochemistry of Cadmium. By James R. DeVoe. Pp. vi+57. 75 cents. NAS–NS–3002: The Radiochemistry of Arsenic. By Harold C. Beard. Pp. vi+27. 50 cents. NAS–NS–3003: The Radiochemistry of Francium. By Earl K. Hyde. Pp. vi+23. 50 cents. (Washington, D.C.: Office of Technical Services, Department of Commerce, 1960.) [224

American Institute of Biological Sciences. Origins of Angiospermous Plants. By A. L. Takhtajian. Translated from the Russian by Mrs. Olga Hess Gankin. Edited by G. Ledyard Stebbins. Pp. i+68. 3.50 dollars. Essays on the Evolutionary Morphology of Plants. By A. L. Takhtajian. Translated from the Russian by Mrs. Olga Hess Gankin. Edited by G. Ledyard Stebbins. Pp. i+139. 5.50 dollars. (Washington, D.C.: American Institute of Biological Sciences, 1958 and 1959.) [224

East Africa High Commission. East African Meteorological Department Annual Report for 1958/59. Pp. ii+34. (Nairobi: Government Printer, 1960.) Sh. 3/50. [224

Canada: Department of Northern Affairs and National Resources. National Museum of Canada. Bulletin No. 164: The Terrestrial Cryptogams of Northern Ellesmere Island. By Rudolph M. Schuster, William C. Steere and John W. Thomson. Pp. iii+132 (4 plates). 2 dollars. Bulletin No. 166: Contributions to Zoology, 1958. Pp. iii+59. 1 dollar. (Ottawa: Queen's Printer, 1959.) [224

World Health Organization. International Work in Leprosy, 1948–1959. Pp. 38. (Reprint from *WHO Chronicle*, 1960, 14, 2–39.) (Geneva: World Health Organization; London: H.M. Stationery Office, 1960.) 1 Swiss franc; 1*s.* 9*d.*; 0.30 dollars. [224

Official Records of the World Health Organization No. 98: The Work of WHO, 1959—Annual Report of the Director-General to the World Health Assembly and to the United Nations. Pp. x+283. (Geneva: World Health Organization; London: H.M. Stationery Office, 1960.) 6 Swiss francs; 10*s.*; 2 dollars. [224

A Dover Sampler: a Collection of Brief Non-Technical Passages from 44 Dover Books Explaining Science, for the Enjoyment of the Science-Minded Browser. Selected and Edited by George Barkin. Pp. 63. (New York: Dover Publications, Inc.; London: Constable and Co., Ltd., 1959.) [224

The Erosion of Victoria Beach: Its Cause and Cure. By Prof. J. E. Webb. (A lecture given before the Philosophical Society, University College, Ibadan, 11 December, 1959.) Pp. 42 (20 figures). (Ibadan: Ibadan University Press, 1960.) 3*s.* 6*d.* [224

Seventy-sixth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1958–1959. Pp. iii+41+4 plates. (Washington, D.C.: Government Printing Office, 1960.) [224

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 39, No. 34 (March 16, 1960): Review of *Pionus maximiliani* (Kuhl). By Ellen Thorne Smith. Pp. 379–385. (Chicago: Chicago Natural History Museum, 1960.) [224

Museum of Comparative Zoology at Harvard College. Breviora, No. 116 (January 6, 1960): Insectivores of the Middle Miocene Split Rock Local Fauna, Wyoming. By Katherine M. Reed. Pp. 11+2 plates. No. 117 (January 20, 1960): Notes on Hispaniolan Herpetology. 1: *Anolis christophei*, New Species, from the Citadel of King Christophe, Haiti. By Ernest E. Williams. Pp. 7. No. 118 (February 24, 1960): A Survey of the Leptodactylid Frogs, Genus *Eupsophus*, in Chile. By José M. Cei. Pp. 13. No. 119 (March 8, 1960): Arctic Archibenthal and Abyssal Mollusks from Drifting Station Alpha. By Arthur H. Clarke, Jr. Pp. 17+1 plate. No. 120 (March 9, 1960): Two Species of Tortoises in Northern South America. By Ernest E. Williams. Pp. 13+3 plates. No. 121 (March 10, 1960): Three New Species of Micrathena (Araneae, Argiopidae) from South America. By Arthur M. Chickering. Pp. 11. No. 122 (March 11, 1960): Notes on Certain Species of Micrathena (Araneae, Argiopidae) from South America. By Arthur M. Chickering. Pp. 7. No. 123 (March 14, 1960): *Alepisaurus brevirostris*, a New Species of Lancetfish from the Western North Atlantic. By Robert H. Gibbs, Jr. Pp. 14. No. 124 (March 15, 1960): Anisian Ammonoids from Malaya. By Bernhard Kummel. Pp. 8+1 plate. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1960.) [224

United States Department of Health, Education, and Welfare: Public Health Service. Publication No. 739: Highlights of Research Progress in General Medical Sciences, 1959—Items of Interest on Research Studies supported by the Division of General Medical Sciences, National Institute of Health, Bethesda 14, Md. Pp. v+23. (Washington, D.C.: Government Printing Office, 1960.) 15 cents. [224

Bulletin of the Museum of Comparative Zoology at Harvard College, Vol. 122, No. 2: A Preliminary Review of the Family Gonostomatidae, with a Key to the Genera and the Description of a New Species from the Tropical Pacific. By Marion Grey. Pp. 57–125. Vol. 122, No. 3: Trichecodon Huxleyi (Mammalia: Odobenidae) in the Pleistocene of South-eastern United States. By Clayton E. Ray. Pp. 127–142+2 plates. Vol. 122, No. 4: Contributions Toward a Reclassification of the Formicidae. 3: Tribe Amblyoponini (Hymenoptera). By William L. Brown, Jr. Pp. 143–230. Vol. 122, No. 5: Land Shells of Navassa Island, West Indies. By Ruth D. Turner. Pp. 231–244+7 plates. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1960.) [224

Fondation Universitaire, Bruxelles. Trente-neuvième Rapport Annuel, 1958–1959. Pp. 144. (Bruxelles: Fondation Universitaire, 1960.) [224

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. ANARE Reports, Series B, Vol. 1: Zoology. The Birds of Heard Island. By M. C. Downes, E. H. M. Ealey, A. M. Gwynn, and P. S. Young. Pp. 135. (Melbourne: Antarctic Division, Department of External Affairs, 1959.) [224

United States Department of the Interior: Fish and Wildlife Service. Fishery Bulletin 167: Estimates of Larval Tuna Abundance in the Central Pacific. By Donald W. Strasburg. Pp. iv+231–255. (Washington, D.C.: Government Printing Office, 1960.) 25 cents. [224

Smithsonian Institution: United States National Museum. Bulletin 217: Birds of Anaktuvuk Pass, Kobuk, and Old Crow: a Study in Arctic Adaptation. By Laurence Irving. Pp. viii+409+13 plates. (Washington, D.C.: Government Printing Office, 1960.) 2 dollars. [224

Republic de Colombia: Departamento de Cordoba. Secretaria de Agricultura y Ganaderia. Estudios de Suelos Preliminares del Departamento de Cordoba. Por Irusta y Fortoul. Pp. 69+4 maps. (Bogota: Instituto de Fomento Algodonero, 1959.) [224

Companhia de Diamantes de Angola (DIAMANG). Servicos Culturais. Dundo–Lunda–Angola. Museu do Dundo. Subsidios de História (Ultramarina e Continental). Publicacoes Culturais No. 47: List of Editions of the *Libro del Infante don Pedro de Portugal*. By F ancis M. Rogers. Pp. 118. (Lisboa: Companhia de Diamantes de Angola, 1960.) [224

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